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NATIONAL DAM SAFETY PROGRAM. LAKE SCHEFFBORG DAM (MO 31442), LA--ETC(U)

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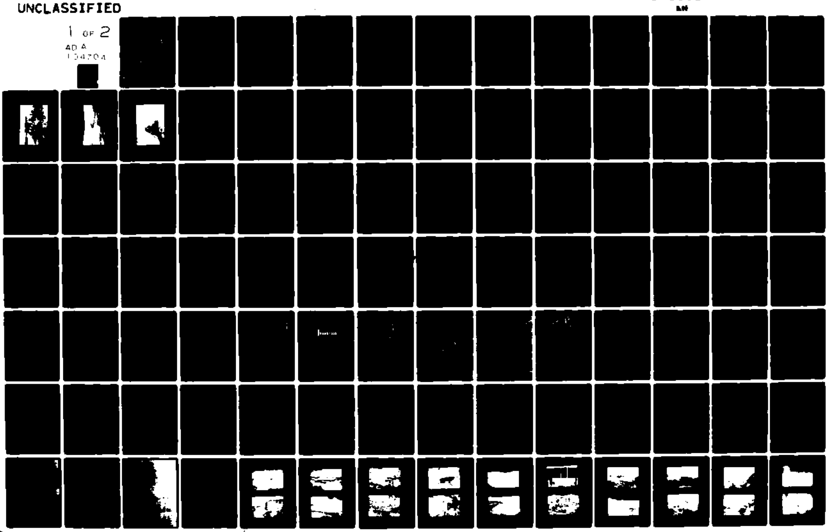

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# MISSOURI - KANSAS CITY BASIN

LAKE SCHEFFBORG DAM MO 31442

LAKE LUCERN DAM MO 30519

LAKE INNSBROOK DAM MO 11243

INNSBROOK DEVELOPMENT

WARREN COUNTY, MISSOURI

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# PHASE 1 INSPECTION REPORT
# NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

## St. Louis District

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to etermine if the dam poses hazards to human life or property.

# MISSOURI - KANSAS CITY BASIN

| | |
|---|---|
| LAKE SCHEFFBORG DAM | MO 31442 |
| LAKE LUCERN DAM | MO 30519 |
| LAKE INNSBROOK DAM | MO 11243 |
| INNSBROOK DEVELOPMENT | |
| WARREN COUNTY, MISSOURI | |

# PHASE 1 INSPECTION REPORT
# NATIONAL DAM SAFETY PROGRAM

United States Army
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**St. Louis District**

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

OCTOBER 1980

**DEPARTMENT OF THE ARMY**
**ST. LOUIS DISTRICT, CORPS OF ENGINEERS**
210 TUCKER BOULEVARD, NORTH
**ST. LOUIS, MISSOURI 63101**

REPLY TO ATTENTION OF

LMSED-PD

6 October 1980

SUBJECT: Lake Scheffborg Dam (MO 31442), Lake Lucern Dam (MO 30519), and Lake Innsbrook Dam (MO 11243) Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of Lake Scheffborg Dam (MO 31442), Lake Lucern Dam (MO 30519), and Lake Innsbrook Dam (MO 11243).

It was prepared under the National Program of Inspection of Non-Federal Dams.

These dams have been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. The combined spillway capacity of each dam will not pass 50 percent of the Probable Maximum Flood without overtopping the dam

b. Overtopping of the dam could result in failure of the dam

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — 11 DEC 1980
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 15 DEC 1980
Colonel, CE, District Engineer — Date

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LAKE SCHEFFBORG DAM - MISSOURI INVENTORY NO. 31442

LAKE LUCERN DAM - MISSOURI INVENTORY NO. 30519

LAKE INNSBROOK DAM - MISSOURI INVENTORY NO. 11243

WARREN COUNTY, MISSOURI

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

OCTOBER 1980

HS-8011

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

| | |
|---|---|
| Name of Dams: | Lake Scheffborg Dam<br>Lake Lucern Dam<br>Lake Innsbrook Dam |
| State Located: | Missouri |
| County Located: | Warren |
| Stream: | Tributary of Charrette Creek |
| Inspection Dates: | 25 July 1980 and 1 August 1980 |

The Lake Scheffborg Dam, the Lake Lucern Dam, and the Lake Innsbrook Dam, all of which are located within the Innsbrook Subdivision development, were visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dams with respect to safety and, based upon these inspections and available data, determine if the dams constitute a hazard to human life or property. These three dams are under common ownership and, for that reason, the results of the investigations of all three dams are contained in this one report.

Lake Innsbrook, the largest of the above lakes with a surface area of approximately 46 acres, is located immediately downstream of Lake Lucern, which has a surface area of about 42 acres. Lake Scheffborg, the smallest lake of the group of about 11 acres, lies approximately 800 feet upstream of Lake Lucern. Six additional lakes that are considered to be of significance to the investigations and recommendations contained herein also lie within the watersheds of Lake Innsbrook, Lake Lucern and Lake Scheffborg. There are several other lakes of significant size within the Innsbrook Subdivision; however, this report presents only the results of the investigations of the dams for Lake Scheffborg, Lake Lucern, and Lake Innsbrook. A plat of the Innsbrook Subdivision showing the relative location of these lakes as well as other planned improvements is presented on Plate 2 of this report.

The following summarizes the findings of the visual inspection and the results of certain hydraulic/hydrologic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of these hydraulic/hydrologic investigations, the present general condition of these dams is considered to be somewhat less than satisfactory. The following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of these dams:

1. The upstream faces of all three dams have only a grass cover to prevent erosion by wave action or fluctuations of the lake surface level. A grass cover is not considered adequate protection to prevent erosion of the embankment by wave action or fluctuations of the lake level. Loss of material by erosion can impair the structural stability of the dam.

2. Seepage was observed at the downstream toe of slopes at the Lake Lucern and Lake Innsbrook Dams. Uncontrolled seepage can develop into a piping condition (progressive internal erosion) that could result in failure of the dams.

3. The valves on the lake drawdown pipes at both the Lake Scheffborg Dam and the Lake Innsbrook Dam were leaking at the time of the inspection and pools of standing water existed adjacent to the downstream toe of each of the dams. Although the pools are relatively small, saturation of the soil adjacent to these dams by standing water can weaken the strength of the material and reduce its capacity to provide foundation support.

4. Numerous small trees exist on the Lake Scheffborg Dam. A few small trees were noted at the Lake Lucern Dam. Several holes, believed to be the remains of old animal burrows, were found along the waterline at both the Lake Lucern and Lake Innsbrook Dams. An animal burrow was also found in the downstream face at the right abutment of the Lake Innsbrook Dam. Tree roots and animal burrows can provide

passageways for lake seepage that could develop into a piping condition.

5. Erosion, apparently by overland drainage, has created several small gulleys in the embankment at the the juction of the downstream slope and the right abutment of the Lake Innsbrook Dam. Loss of material by erosion can impair the structural stability of the dam.

6. Numerous large fallen trees exist within the spillway outlet channel for the Lake Scheffborg Dam. A single large fallen tree was also present within the outlet channel for Lake Innsbrook. Obstructions such as large trees, etc., can impede flow within the channel reducing its outlet capacity which could result in channel overflow impinging upon the dam and erosion of the embankment. Obstructions within the channel can also cause turbulence in the flow which can increase the tendency for erosion.

7. The spillway outlet channels for all three dams show evidence of erosion with the more extensive erosion having occurred at the outlet channels for the Lake Scheffborg and the Lake Lucern Dams. Due to the fact that these channels are located in abutment areas, i.e., undisturbed natural ground, and the fact that the eroded areas are for the most part located away from the dams, the condition of these channels does not appear at this time to offer any serious problems to their respective dams. A possible exception would be blockage of the channel by a slide that could occur should the channel banks become unstable. This condition is more likely to occur at the Lake Scheffborg Dam where the channel banks are quite steep and very high. It is recommended that the Owner monitor the outlet channels for evidence of instability and erosion that could cause the channels to encroach upon the dams or become blocked.

8. At the time of the inspection and with the exception of the crests of the Lake Lucern and Lake Innsbrook Dams, the grass on the dams was up to 3 feet in height. Grass on a dam should be maintained at a height that will not provide cover for burrowing animals or hinder inspection of the dam.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Lake Scheffborg and Lake Lucern Dams, which are classified as small in size and of high hazard potential, is specified to be a minimum of one-half the Probable Maximum Flood; whereas the spillway design flood for the Lake Innsbrook Dam, which is classifed as intermediate in size and of high hazard potential, is specified to be the full Probable Maximum Flood. Considering the fact that failure of an upstream dam(s) may cause failure of the downstream dam(s), which in turn would endanger the lives of a number of people with dwellings located within the possible flood damage zones for these dam(s), it is recommended that the spillways for the Lake Scheffborg and Lake Lucern Dams also be designed for the Probable Maximum Flood. The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is ordinarily accepted as the inflow design flood for dams where failure of the structure would increase the danger to human life.

Results of a hydraulic/hydrologic analysis indicated that the existing spillways are inadequate to pass the outflow resulting from a storm of PMF magnitude without overtopping their respective dams. The spillways are capable of passing lake outflows corresponding to the following percentages of PMF lake inflows, without overtopping their respective dams:

| Lake Spillway | Percent PMF |
|---|---|
| Scheffborg | 18 |
| Lucern | 20 |
| Innsbrook | 14 |

In the determination of lake outflow for the above lakes, the runoff was routed through the lakes lying upstream of the dam being analyzed. In all, there are nine lakes that lie within the Lake Innsbrook watershed that were considered in the investigations of dam overtopping presented herein. Six of these lakes are located outside of the Innsbrook Subdivision development. Of the six lakes two lie upstream of Lake Scheffborg; one lies upstream of Lake Lucern; and, the remaining three lie upstream of Lake Innsbrook. The relative

location of all nine lakes including their respective watershed boundaries is shown on Plate 3 of this report.

Where it was found that the spillway capacity of an upstream dam was less than 50 percent of the PMF inflow, it was assumed that once dam overtopping took place, failure of the dam by breaching would occur and a breaching analysis of the failed dam was made. Since it was found that the spillway capacity of Dam A was less than 50 percent of the PMF, it was assumed in the PMF overtopping analysis for the Lake Scheffborg Dam, that Dam A had breached. Since spillway capacity of the Lake Scheffborg Dam was found to be less than 50 percent of the PMF, it was assumed in the PMF overtopping analysis for the Lake Lucern Dam that the Lake Scheffborg Dam had breached. Also, since it was determined that the spillway capacity of the Lake Lucern Dam was less than 50 percent of the PMF, it was assumed in the overtopping analysis for the Lake Innsbrook Dam that the Lake Lucern Dam as well as the Lake Scheffborg Dam had failed. It was also determined that the capacities of the spillways for Dam 30520 and Dam 31443 as well as Dam C were all less than 50 percent of the PMF, and therefore, were also considered to have breached in the PMF overtopping analysis of the Lake Innsbrook Dam. Dams B and 30512 were found to have spillway capacities equal to or in excess of 50 percent of the PMF and therefore were not assumed to breach when overtopping occurred.

It was determined that the existing spillways for the Lake Scheffborg, Lake Lucern, and Lake Innsbrook Dams were capable of passing lake outflow resulting from the 1 percent probability (100-year frequency) flood. It was also determined that the spillways for Dams A and C were not adequate to pass the outflow resulting from the 1 percent probability flood and that during this event dam overtopping would occur. Since in both instances the maximum depth of overtopping was found to be relatively small (0.14 feet for Dam A and 0.35 feet for Dam C), failure of these upstream dams during overtopping resulting from the 1 percent probability flood, was not assumed.

According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of only the Lake Scheffborg Dam occur, is estimated to be one mile. Within the possible damage zone is Lake Lucern

(the dam for Lake Lucern is located about 0.8 mile downstream of the Lake Scheffborg Dam) including several dwellings which are located about the lake shoreline. The length of the downstream damage zone, should failure of only the Lake Lucern Dam occur, is estimated to be six miles. Within the damage zone are Lake Innsbrook (the dam for Lake Innsbrook is located about 0.6 mile downstream of the Lake Lucern Dam), several dwellings, a house trailer, and numerous other buildings. The length of the downstream damage zone, should failure of only the Lake Innsbrook Dam occur, is estimated to be five miles. Within the damage zone are several dwellings, a house trailer, and numerous other buildings. No data regarding the length or description of the downstream damage zone was provided should successive failure of the dams for Lake Scheffborg, Lake Lucern, and Lake Innsbrook occur.

A review of available data did not disclose that seepage or stability analyses of these dams were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action within a reasonable time to correct or control the deficiencies and safety defects reported herein. The provision of additional spillway capacity should be pursued on a high priority basis.

Ralph E. Sauthoff

Ralph E. Sauthoff
P. E. Missouri E-19090

Albert B. Becker, Jr.

Albert B. Becker, Jr.
P. E. Missouri E-9168

OVERVIEW [illegible]

OVERVIEW LAKE [illegible]

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE SCHEFFBORG DAM - MO 31442
LAKE LUCERN DAM - MO 30519
LAKE INNSBROOK DAM - MO 11243

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APPENDIX B - HYDROLOGIC AND HYDRAULIC ANALYSES



*Drawings by Lewis & Associates (County Engineering and Surveying), Warrenton, Missouri, September, 1974.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

LAKE SCHEFFBORG DAM - MO 31442
LAKE LUCERN DAM - MO 30519
LAKE INNSBROOK DAM - MO 11243

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, directed that a safety inspection of the Lake Scheffborg, Lake Lucern, and Lake Innsbrook Dams be made.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of each of the above dams with respect to safety and, based upon available data and this inspection, determine if any of these dams poses a hazard to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Non-Federal Dams", dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. General. Lake Scheffborg, Lake Lucern, and Lake Innsbrook are a group of lakes that lie within the development known as Innsbrook, a subdivision consisting mostly of weekend and/or summer homes, located approximately four miles south of Wright City, Missouri. Lake Scheffborg, Lake Lucern, and Lake Innsbrook are arranged in tandem fashion along an

unnamed tributary of Charrette Creek. The Lake Innsbrook Dam is located just downstream of the junction of two drainage systems, creating a lake with two arms of approximately equal size. The western arm of Lake Innsbrook abuts the dam for Lake Lucern and Lake Lucern extends upstream to a point about 800 feet downstream of Lake Scheffborg. At normal pool level, Lake Scheffborg occupies approximately 11 acres; Lake Lucern about 42 acres; and Lake Innsbrook about 46 acres. A plat of the Innsbrook Subdivision development showing the lakes, lots, and streets, is shown on Plate 2.

b. Description of Dams and Appurtenances.

(1) Lake Scheffborg Dam. The Lake Scheffborg Dam is an earthfill type embankment, rising approximately 29 feet above the original streambed at the downstream toe of the barrier. The embankment has an upstream slope above the waterline of approximately 1v on 2.3h, a crest width of about 15 feet, and a downstream slope on the order of 1v on 3.1h. The length of the dam is approximately 363 feet. A railroad tie retaining wall about 3 feet high and 20 feet long has been constructed in the upstream face of the dam near the right abutment, and some of the embankment removed to provide a beach area. A 15-inch steel pipe with a control valve located near the downstream end of the pipe is provided to dewater the lake. A plan and profile of the dam is shown on Plate 4 and a cross-section of the dam is shown on Plate 5.

The spillway, a trapezoidal section excavated to bedrock through the crest area, is located at the left, or east, end of the dam. The spillway outlet channel, an excavated trapezoidal section that is severely eroded downstream of the crest area, directs flow away from the dam and into the valley below the dam where it follows a course which joins the original stream at a point about 250 feet downstream of the dam. A profile of the spillway channel is shown on Plate 5 and a cross-section of the channel is presented on Plate 6.

(2) Lake Lucern Dam. The Lake Lucern Dam is an earthfill type embankment rising approximately 30 feet above the original streambed. The embankment has an upstream slope above the waterline of about 1v on 3.6h, a crest width of approximately 26 feet, and a downstream slope on the order of 1v on 3.0h. The length of the dam is approximately 675 feet and an asphalt

paved road traverses the dam crest. With the exception of a slide gate located in the drop inlet, the dam has no lake drawdown facility to dewater the lake. A plan and profile of the dam is shown on Plate 7 and a cross-section of the dam is shown on Plate 8.

The dam has both a principal and emergency spillway. The principal spillway, a 60-inch diameter steel drop inlet with a 30-inch diameter steel outlet pipe, is located near the left, or east, abutment. A profile of the principal spillway is shown on Plate 8. A steel slide gate installed in the upstream side of the drop inlet extends about 36 inches below the top of the inlet to facilitate lake drawdown. The spillway outlet pipe discharges to an irregular excavated channel which directs flow away from the dam and joins Lake Innsbrook about 200 feet downstream of the center of the dam.

The emergency spillway, a broad, dish-shaped, excavated earth section that is extensively eroded in several locations, is also located near the left end of the dam. A profile and cross-section of the emergency spillway is shown on Plate 9. The paved roadway which traverses the dam also crosses the crest of the emergency spillway. The emergency spillway outlet channel joins the principal spillway outlet channel about 160 feet downstream of the dam.

(3) Lake Innsbrook Dam. The Lake Innsbrook Dam is an earthfill type embankment rising approximately 47 feet above the original streambed. The embankment has an upstream slope above the waterline of about 1v on 3.5h, a crest width of approximately 31 feet, and a downstream slope on the order of 1v on 2.9h. The length of the dam is approximately 525 feet and a road with a bituminous surface traverses the dam crest. A 12-inch steel pipe with a control valve located near the downstream end of the pipe is provided to dewater the lake. Downstream of the control valve, the drain pipe is reduced to an 8-inch PVC pipe which discharges about 100 feet downstream of the toe of the dam. A 2.5-inch diameter plug valve is provided at the low point in the pipe to drain the PVC line. A plan and profile of the dam is shown on Plate 10 and a cross-section of the dam is shown on Plate 11.

The dam has both a principal and emergency spillway. The principal spillway, a 60-inch diameter steel drop inlet with a 36-inch diameter steel

outlet pipe is located near the left, or east, abutment. A profile of the principal spillway is shown on Plate 11. A steel slide gate installed in the upstream side of the drop inlet extends about 54 inches below the top of the inlet to facilitate lake drawdown. The spillway outlet pipe discharges to an irregular excavated trapezoidal channel which joins the original stream about 300 feet downstream of the dam.

The emergency spillway, a trapezoidal excavated earth section, is also located near the left end of the dam. A profile and cross-section of the emergency spillway is shown on Plate 12. The paved roadway which traverses the dam crosses the emergency spillway about 150 feet downstream of the dam. At a point approximately 50 feet below the road, the emergency spillway channel joins the principal spillway outlet channel.

c. Location. The Lake Scheffborg Dam is located in the southeast quarter of Section 31, Township 47 North, Range 1 West; the Lake Lucern Dam is located in the southeast quarter of Section 6, Township 46 North, Range 1 West; and the Lake Innsbrook Dam is located in the northwest quarter of Section 8, Township 46 North, Range 1 West, all in Warren County, Missouri. The three dams lie within the Innsbrook Subdivision, the entrance to which is located on the west side of State Highway F, about 2 miles south of State Highway M, and approximately 4 miles southwest of Wright City, Missouri, as shown on the Regional Vicinity Map, Plate 1.

d. Size Classification. The size classification based on the height and storage capacity of each dam, is categorized as small for both the Lake Scheffborg Dam and the Lake Lucern Dam, and intermediate for the Lake Innsbrook Dam (per Table 1, Recommended Guidelines for Safety Inspection of Dams).

e. Hazard Classification. According to the St. Louis District, Corps of Engineers, the Lake Scheffborg, Lake Lucern, and Lake Innsbrook Dams have a high hazard potential meaning that if any one of these dams should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone,

should failure of only the Lake Scheffborg Dam occur, as determined by the St. Louis District, extends one mile downstream of the dam. Within the possible damage zone is Lake Lucern (the dam for Lake Lucern is located about 0.8 mile downstream of the Lake Scheffborg Dam) including several dwellings which are located about the lake shoreline. The length of the downstream damage zone, should failure of only the Lake Lucern Dam occur, is estimated to be six miles. Within the damage zone are Lake Innsbrook (the dam for Lake Innsbrook is located about 0.6 mile downstream of the Lake Lucern Dam), several dwellings, a house trailer, and numerous other buildings. The length of the downstream damage zone, should failure of only the Lake Innsbrook Dam occur, is estimated to be five miles. Within the damage zone are several dwellings, a house trailer, and numerous other buildings. No data regarding the length or description of the downstream damage zone should successive failure of the dams for Lake Scheffborg, Lake Lucern, and Lake Innsbrook occur, was provided. Those features lying within the downstream damage zones reported by the Corps of Engineers, St. Louis District, were verified by the inspection team.

f. Ownership. The Innsbrook development, including the dams, is owned by the Aspenhof Corporation, 165 North Meramec, St. Louis, Missouri, 63105. Mr. Steven G. Woebbe, Vice-President, Aspenhof Corporation, is the Owner's representative.

g. Purpose of Dams. The dams impound water for recreational use by property owners within the Innsbrook development.

h. Design and Construction History. According to Mr. William Scheff, the original owner of Lake Scheffborg, the dam was designed and constructed in 1973 by Russell Bolinger, a local earth excavating contractor and builder of earthen dams. Mr. Bolinger is deceased, and no records of the design or construction of the dam were available.

According to Mr. Steven Woebbe, a representative of the Owner, the Lake Lucern Dam was also constructed by Russell Bolinger in 1971. Mr. Woebbe also indicated that Lewis and Associates (presently County Engineering and Surveying Company, Inc.) of Warrenton, Missouri, assisted in the design of the dam. No records of the design or construction of the dam were available.

Mr. Woebbe also reported that, the Lake Innsbrook Dam was designed by Lewis and Associates and constructed by the Magruder Excavating Company of Eolia, Missouri in 1974. With the exception of two preliminary drawings prepared by Lewis and Associates in 1974, no records relating to the design or construction of the dam were available.

i. Normal Operational Procedures. The level of each lake is unregulated. The level of Lake Scheffborg is governed by the capacity of an excavated earth type spillway. The levels of Lake Lucern and Lake Innsbrook are each governed by the respective combined capacities of drop inlet type spillways and excavated earth type emergency spillways.

## 1.3 PERTINENT DATA

a. Drainage Areas. The areas tributary to these lakes consist mostly of forestlands in the southern one-half of the watershed, and about equal amounts of forestland and meadowland in the northern one-half. Much of the Innsbrook subdivision is tributary to the three lakes. Since the lots within the subdivision are fairly large and the topography has for the most part been preserved in a native state covered with timber, the entire watershed is considered to be primarily rural. Six additional lakes and dams, which because of their size, were considered of significance to the hydraulic/hydrologic analysis, also lie within the watershed. The watershed area above the Lake Scheffborg Dam amounts to approximately 569 acres; above the Lake Lucern Dam, about 1,440 acres; and above the Lake Innsbrook Dam, about 2,470 acres. The watershed boundaries are outlined on Plate 3.

b. Discharge at Damsite.

(1) Lake Scheffborg Dam.

A. Estimated known maximum flood at damsite* ... 82 cfs (W.S. Elev. 724.5)

B. Spillway capacity ... 1,300 cfs (W.S.Elev. 728.4)

*Based on an estimate of depth of flow at spillway per the Owner's representative.

(2) Lake Lucern Dam.

A. Estimated known maximum flood at damsite* ... 191 cfs (W.S. Elev. 694.4)

B. Spillway capacity (principal) ... 54 cfs (W.S. Elev. 693.4)

C. Spillway capacity (principal + emergency) ... 2,465 cfs (W.S. Elev. 697.2)

(3) Lake Innsbrook Dam.

A. Estimated known maximum flood at damsite* ... 79 cfs (W.S. Elev. 671.1)

B. Spillway capacity (principal) ... 88 cfs (W.S.Elev. 673.1)

C. Spillway capacity (principal + emergency) ... 1,088 cfs (W.S. Elev. 678.7)

c. Elevation (Ft. above MSL). The following elevations were determined by survey and are based on the elevation of Lake Lucern, assumed to be the normal pool level (top of the drop inlet spillway), as shown on the 1972 Wright City, Missouri, Quadrangle Map, 7.5 Minute Series.

(1) Lake Scheffborg Dam.

A. Observed pool ... 723.1

B. Normal pool ... 723.5

C. Spillway crest ... 723.5

D. Maximum experienced pool* ... 724.5

E. Top of dam ... 728.4 (min.)

F. Streambed at centerline of dam ... 701 $\pm$ (Est.)

G. Maximum tailwater ... Unknown

H. Observed tailwater ... None

(2) Lake Lucern Dam.

A. Observed pool ... 691.1

B. Normal pool ... 692.0

*Based on an estimate of depth of flow at spillway per the Owner's representative.

C. Spillway crest ...

1. Principal ... 692.0

2. Emergency ... 693.4

D. Maximum experienced pool* ... 694.4

E. Top of dam ... 697.2 (min.)

F. Streambed at centerline of dam ... 669 ± (Est.)

G. Maximum tailwater ... 671.1 (Lake Innsbrook)

H. Observed tailwater ... 668.4 (Lake Innsbrook)

(3) Lake Innsbrook Dam.

A. Observed pool ... 668.4

B. Normal pool ... 668.6

C. Spillway crest ...

1. Principal ... 668.6

2. Emergency ... 673.1

D. Maximum experienced pool* ... 671.1

E. Top of dam ... 678.7 (min.)

F. Streambed at centerline of dam ... 633 ± (Est.)

G. Maximum tailwater ... Unknown

H. Observed tailwater ... None

d. Reservoir.

(1) Lake Scheffborg Dam.

A. Length at normal pool (Elev. 723.5) ... 1,700 ft.

B. Length at maximum pool (Elev. 728.4) ... 2,100 ft.

(2) Lake Lucern Dam.

A. Length at normal pool (Elev. 692.0) ... 3,200 ft.

B. Length at maximum pool (Elev. 697.1) ... 3,600 ft.

(3) Lake Innsbrook Dam.

A. Length at normal pool (Elev. 668.6) ... 2,900 ft.

B. Length at maximum pool (Elev. 678.7) ... 3,900 ft.

*Based on an estimate of depth of flow at spillway per the Owner's representative.

e. Storage.

(1) Lake Scheffborg Dam.

A. Normal pool ... 79 ac. ft.

B. Top of dam (incremental) ... 65 ac. ft.

(2) Lake Lucern Dam.

A. Normal pool ... 338 ac. ft.

B. Top of dam (incremental) ... 244 ac. ft.

(3) Lake Innsbrook Dam.

A. Normal pool ... 516 ac. ft.

B. Top of dam (incremental) ... 552 ac. ft.

f. Reservoir Surface.

(1) Lake Scheffborg Dam.

A. Normal pool ... 11 acres

B. Top of dam (incremental) ... 5 acres

(2) Lake Lucern Dam.

A. Normal pool ... 42 acres

B. Top of dam (incremental) ... 10 acres

(3) Lake Innsbrook Dam.

A. Normal pool ... 46 acres

B. Top of dam (incremental) ... 18 acres.

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier, to the top of the dam.

(1) Lake Scheffborg Dam.

A. Type ... Earthfill, homogeneous*

*Per original dam owner.

B. Length ... 363 ft.

C. Height ... 29 ft.

D. Top width ... 15 ft.

E. Side Slopes

1. Upstream ... 1v on 2.3h (above waterline)

2. Downstream ... 1v on 3.1h

F. Cutoff ... Core trench*

G. Slope protection

1. Upstream ... Grass

2. Downstream ... Grass

(2) Lake Lucern Dam.

A. Type ... Earthfill, homogeneous**

B. Length ... 675 ft.

C. Height ... 30 ft.

D. Top width ... 26 ft.

E. Side slopes

1. Upstream ... 1v on 3.6h (above waterline)

2. Downstream ... Irregular 1v on 3.0h

F. Cutoff ... Core trench**

G. Slope protection

1. Upstream ... Grass

2. Downstream ... Grass

(3) Lake Innsbrook Dam.

A. Type ... Earthfill, homogeneous**

B. Length ... 525 ft.

C. Height ... 47 ft.

D. Top width ... 31 ft.

E. Side slopes

1. Upstream ... 1v on 3.5h (above waterline)

2. Downstream ... 1v on 2.9h

F. Cutoff ... Core trench**

*Per original dam owner.

**Per dam builder and/or Owner's representative.

G. Slope protection

1. Upstream ... Grass

2. Downstream ... Grass

h. Principal Spillway.

(1) Lake Scheffborg Dam.

A. Type ... Uncontrolled, excavated earth, rock bottom, trapezoidal section

B. Location ... Left abutment

C. Crest ... Elevation 723.5

D. Approach channel ... Lake

E. Outlet channel ... Excavated earth, irregular trapezoidal section

(2) Lake Lucern Dam.

A. Type ... Uncontrolled, drop inlet, 60-inch diameter steel with anti-vortex plate

B. Location ... Left abutment within lake

C. Top elevation ... 692.0

D. Outlet ... 30-inch diameter steel pipe

(3) Lake Innsbrook Dam.

A. Type ... Uncontrolled, drop inlet, 60-inch diameter steel

B. Location ... Left abutment within lake

C. Top elevation ... 668.6

D. Outlet ... 36-inch diameter steel pipe

i. Emergency Spillway.

(1) Lake Scheffborg Dam ... None

(2) Lake Lucern Dam.

A. Type ... Uncontrolled, excavated earth, dish-shaped section

B. Location ... Left abutment

C. Crest ... Elevation 693.4

D. Approach channel ... Lake

E. Outlet channel ... Excavated earth, irregular trapezoidal section

(3) Lake Innsbrook Dam.

A. Type ... Uncontrolled, excavated earth, trapezoidal section

B. Location ... Left abutment

C. Crest ... Elevation 673.1

D. Approach channel ... Lake

E. Outlet channel ... Excavated earth, irregular trapezoidal section

j. Lake Drawdown Facilities.

(1) Lake Scheffborg Dam.

A. Type ... 15-inch diameter steel pipe

B. Control ... Gate valve near downstream end of pipe

C. Outlet ... Toe of dam

(2) Lake Lucern Dam.

A. Type ... Fabricated steel slide gate located in wall of spillway drop inlet

B. Size ... 36 inches high, 28 inches wide

C. Outlet ... Spillway outlet pipe

(3) Lake Innsbrook Dam.

A. Drain pipe

1. Type ... 12-inch diameter steel pipe, reduced to 8-inch PVC pipe at toe of dam
2. Control ... 12-inch gate valve near toe of dam
3. Outlet ... About 100 feet downstream of toe of dam

B. Drawdown gate

1. Type ... Fabricated steel slide gate located in wall of spillway drop inlet
2. Size ... 54 inches high, 30 inches wide
3. Outlet ... Spillway outlet pipe

SECTION 2 - ENGINEERING DATA

## 2.1 DESIGN

Data relating to the design of the Lake Scheffborg Dam or the Lake Lucern Dam were unavailable.

As stated previously, preliminary plans for the construction of the Lake Innsbrook Dam were prepared in 1974 by Lewis and Associates (presently County Engineering and Surveying Co., Inc.) of Warrenton, Missouri. The extent to which these plans were followed during the construction of the dam is unknown. A copy of the preliminary plans were obtained from County Engineering, and are included as Plates 13 and 14 of this report. No additional data relating to the design of the Lake Innsbrook Dam were available.

According to Mr. Steven Woebbe of the Aspenhof Corporation, the size of the spillways for the Lake Lucern and Lake Innsbrook Dams were furnished by Lewis & Associates. A drop inlet type spillway of the proportions constructed at the Lake Innsbrook Dam is shown on Sheet 1, reference Plate 13, of the plans prepared by Lewis. Mr. Harry Badde of Lewis & Associates when interviewed stated that the drawings for the dam were more or less preliminary and that the elevations shown on the drawing, Sheet 1, were based on topography obtained from the USGS Wright City Quadrangle Map. The basis of the elevations shown on Sheet 2, reference Plate 14, is not clear. The details shown on Sheet 2 for the lake drawdown pipe as far as pipe size and location of the control valve are concerned, do appear to be similar to that installed at the Lake Innsbrook Dam. Mr. Badde also stated that advice was furnished the contractor during construction of the Lake Lucern and Lake Innsbrook Dams.

## 2.2 CONSTRUCTION

As previously stated, the Lake Scheffborg Dam was constructed in about 1973 by Russell Bolinger, a local earth excavating contractor and builder of

earthen dams. According to Mr. William Scheff, the original owner of the dam, a core trench for seepage cutoff was excavated along the axis of the dam. The Owner reported that the material used to backfill the trench and construct the dam was clay that was selected from an area located to the north of the lake. The Owner also recalled that the embankment material was compacted using a sheepsfoot roller. No records of the construction of the dam were available.

According to Mr. Steven Woebbe, the Lake Lucern Dam was also constructed by Russell Bolinger. Mr. Woebbe reported that a seepage cutoff core was constructed along the axis of the dam and that the base of the trench and excavations at the abutments were inspected by Lewis & Associates prior to placing embankment material. No other information or records relating to the construction of the dam were available.

The dam for Lake Innsbrook was constructed during the fall and early winter of 1974 by the Magruder Construction Company of Eolia, Missouri. According to Mr. Warren Magruder, a core trench for seepage cutoff about 12-to-15 feet wide was excavated along the axis of the dam. Mr. Magruder indicated that the core trench was excavated through several layers of gravel to good clay. Mr. Magruder also mentioned that the less desirable material excavated from the core trench was utilized as fill in the downstream side of the embankment near the toe and that the remainder of the fill for the core trench and dam was clay obtained from areas to be occupied by the lake. According to Mr. Magruder, the fill was compacted by the earth moving equipment, scrapers, used to construct the dam. Mr. Magruder indicated that plans for the dam were not provided and that stakes for construction of the dam were furnished by the Owner. Mr. Magruder recalled that seepage collars were constructed about the lake drawdown pipe.

## 2.3 OPERATION

The lake levels of the three lakes are uncontrolled. The level of Lake Scheffborg is governed by the crest elevation of the excavated earth type spillway. The levels of Lake Lucern and Lake Innsbrook are governed by the crest elevations of their respective drop inlet type principal spillways and excavated earth type emergency spillways.

No indication was found that the dams have been overtopped. According to Mr. Steven Woebbe, the dams have never been overtopped and the highest level experienced to date produced a lake surface estimated to be approximately 1.0 foot higher than the normal level (spillway crest) at Lake Scheffborg; about 1.0 foot higher than the crest of the emergency spillway at Lake Lucern; and about 2.5 feet higher than the normal level (top of drop inlet) at Lake Innsbrook.

## 2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dams and spillways were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

a. General. A visual inspection of the Lake Scheffborg Dam, the Lake Lucern Dam, and the Lake Innsbrook Dam, was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, T. K. Deddens, Geological Engineer, and A. B. Becker, Jr., Civil and Soils Engineer, on 25 July 1980 and 1 August 1980. An examination of the dam sites was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the area geology. Also examined at the time of the inspection were the areas and features below the dams within the potential flood damage zone. Photographs of the dams taken at the time of the inspection are included on pages A-1 through A-17 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plates 4, 7 and 10.

b. Area Geology.

(1) General. The dam sites are located near the southern edge of the Dissected Till Plains Section of the Central Lowlands Physiographic Province and the northern edge of the Salem Plateau Section of the Ozark Plateaus Province. The topography is moderately rugged with up to 160 feet of relief between the reservoirs and the surrounding drainage divides. Bedrock outcrops are limited to steep slopes along the original stream channels and in spillway cuts. Borings in the general area indicate loess and glacial till reach over 100 feet in thickness in some areas. The bedrock at the dam sites consists of Ordovician-age sedimentary rock of the Kimmswick and the overlying Maquoketa formations. The bedrock is dipping slightly to the north, and no faults were observed or reported in the immediate area of the dams.

The Kimmswick formation is a light gray, coarsely crystalline, medium-bedded to massive limestone. Weathered exposures characteristically appear pitted. The limestones are susceptible to solution weathering and may have solution-enlarged joints and bedding planes, sinkholes, etc. These karst features can be the cause of considerable leakage from water impoundments

when soil cover is thin. The overlying Maquoketa formation is a thinly laminated, silty, calcareous or dolomitic shale. Locally the formation consists of greenish-gray to gray shales in the lower part of the exposed section. The shales grade upward to a thin, sandy shale, capped with thin interbedded limestones and shales.

The unconsolidated surficial materials in the area consist of thick deposits of loess, glacial till, alluvium and residual cherty clays. The reservoirs are located primarily on the aluvium, till, and residuum. The loess deposits cap the surrounding uplands. The valley bottom is covered by soils of the Cedargap series. These deposits consist of deep, somewhat excessively drained, soils formed in alluvium. The series varies from a dark grayish-brown, cherty silt at the surface to a more cherty and clayey material at depth. According to the Unified Soil Classification system, the soils are classified as ML to GC materials, are permeable, and may allow seepage. The more silty material may be subject to piping and erosion.

The valley walls are covered primarily by glacial till consisting of the Lindley and Keswick series. The Lindley series are deep, well-drained soils consisting of a silty clay at the surface, becoming more clayey with depth. Chert fragments from the reworked residual soils are common. The soils are classifed as CL-ML to CL materials, exhibit moderately low permeability, and are generally considered favorable for reservoirs and embankments. The Keswick soils are deep, moderately well-drained materials consisting of dark grayish-brown silty clays near the surface, becoming more clayey with depth. The soils are classified as CL or CL-ML materials, are low in permeability, but are susceptible to erosion.

Residual soils are exposed in several large areas and probably are present under the tills throughout the area. The residual soils consist of the Goss series. This series is composed of deep, well-drained soils formed in material weathered from carbonate bedrock. The soil typically ranges from a dark grayish-brown to brown, very cherty, silty clay at the surface to a yellowish-brown, firm, very cherty clay at depth. The soil ranges from a GM to GC material, is moderatly permeable, and compressible. Reportedly, seepage from water impoundments is common in these soils.

(2) Lake Scheffborg Dam. Some minor erosion was noted in the residual soils above the spillway cut and in the till around the shoreline. The most significant geologic problem observed was the erosion in the spillway outlet channel. The bottom of the spillway cut is on thin-bedded limestones which overlay soft shales; however, immediately downstream from the cut the protective limestone layers are absent. The shales are soft and poorly cemented and highly susceptible to erosion. Flow passing the spillway has eroded a deep channel in the shales which extends to the original stream channel. The erodibility of these shales would probably not be a threat to the performance of the dam for a long period of time because of the amount of limestone cap rock still present in the spillway cut.

(3) Lake Lucern Dam. Some minor erosion of Lindley soils was observed along the shoreline near the east abutment. The most significant geologic condition at the site was observed on the east abutment which is formed by limestone, sandstone, and shale rubble. The bedrock is disturbed and no original bedding is apparent. This is thought to be an old landslide deposit in the Maquoketa formation that moved down from the nearby valley wall. The slide appears to have stabilized long ago and shows no signs of geologically recent movement. Significant erosion has occurred in these deposits. Erosion in the spillway channel has cut deep gullies into the shale rubble of the abutment parallel to the spillway channel. Although the landslide deposit appears to have stabilized, the soft nature of the shales and destruction of the competency of beds by sliding has made the material highly susceptible to erosion.

(4) Lake Innsbrook Dam. Some minor seepage was observed along the contact between the embankment and original valley fill. The spillway is cut through limestone and no severe erosion has occurred in the spillway channel. Only minor erosion of soils has occurred around the reservoir area. No geologic conditions were observed that would be considered detrimental to reservoir or embankment performance.

c. Dams.

(1) Lake Scheffborg Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1 and 2) as well as the dam crest were inspected and found to be in sound condition, although erosion, apparently by wave action or fluctuations of the lake level, had created a near vertical bank up to 18 inches high along the unprotected (no riprap) upstream face at the normal waterline. The 3-foot high railroad tie type retaining walls supporting the embankment about the beach area (see Photo 3) at the right end of the dam were also examined and found to be in satisfactory condition. No evidence of instability of the walls was observed. No surface cracks, sloughing of the embankment slopes, or unusual settlement of the dam were noted. Numerous small trees up to about 2-inches in diameter were present on the downstream face and several trees up to about 1 inch in size were found on the crest and upstream face of the dam. At the time of the inspection, the grass on the dam, a fescue type, was up to 3 feet high. Examination of a soil sample obtained from the downstream face of the dam indicated the material to be a silty lean clay (CL) of low-to-medium plasticity.

Examination of the spillway outlet channel indicated the section at the crest (see Photo 4) to be in good condition without any significant erosion of the bedrock invert or earthen banks. However, beginning at a point approximately 150 feet downstream of the centerline of the dam, the exit section of the channel was severely eroded. A large pothole (see Photo 5), approximately 15 feet in diameter and about 18 feet in depth on the upstream end and 5 feet in depth on the downstream end was found within the channel at a point about 180 feet downstream of the dam centerline. The pothole appeared to be a result of scour by spillway releases of the very friable, shaley material present within the channel at this location. Beginning just downstream of the pothole, the channel was found to be littered by a succession of large fallen trees (see Photo 6). It was apparent that many of the trees within the channel were there as a result of erosion of their bases by spillway releases.

The outlet end of the 15-inch steel lake drawdown pipe (see Photo 8) was inspected and except for some minor corrosion of the surface, appeared to

be in satisfactory condition. Due to the fact that an old cast-iron valve body prevented the removal of the cover on the valve enclosure (see Photo 7), inspection of the valve could not be made. However, since lake water, estimated to be flowing at about 2 gpm, was flowing from the end of the pipe, it was apparent that the valve was experiencing minor leakage. Just downstream of the pipe, a pool of water approximately 2 feet deep and about 5 feet wide and 10 feet long was found. Presumably, flow discharging from the lake drawdown pipe had scoured a depression in the ground surface which created the pool. Willow trees were observed in the area adjacent to and just downstream of the end of the pipe, but except for the small stream leaving the pool, the ground surface in the vicinity of the willows was firm and dry and no seepage was observed.

(2) Lake Lucern Dam. The visible portions of the upstream and downstream faces of the dam as well as the dam crest (see Photos 9 and 10) were inspected and, except as noted, were found to be in sound condition. No significant cracking of the asphalt paved roadway or grass covered crest area was observed, and no sloughng of the embankment slopes or unusual settlement of the crest was noted. At the unprotected (no riprap) upstream face, erosion that appeared to be a result of wave action or fluctuations of the lake level, had created a near vertical bank (see Photo 20) up to about 36 inches high along most of the dam. A similar condition, but only about 12 inches high, was found along the toe of the dam where the downstream slope met Lake Innsbrook. Undercutting of the banks, as mich as 12 inches, was also observed at several locations along both the upstream and downstream slopes at the waterlines. Several holes believed to be both new and old animal burrows were found near the right end of the dam at the upstream and downstream waterlines. At the time of the inspection, the grass on the dam slopes, a fescue type, was approximately 3 feet high. A few small trees were present at the left side of the dam near the spillway outlet channel. Examination of a soil sample obtained from the downstream face of the dam indicated the material to be a silty lean clay (CL) of low-to-medium plasticity.

Seepage, as evidenced by a marshy area approximately 15 feet wide and 75 feet long (see Photo 19) with cattails, soft ground and standing water, was observed adjacent to the downstream toe at the right side of the dam. Since flowing water was not noticed, no estimate of seepage rate could be made.

Inspection of the 5-foot diameter steel drop inlet spillway structure (see Photo 11) and its 30-inch diameter steel outlet pipe (see Photo 12) indicated the facility to be in satisfactory condition, although oxidation of the unprotected steel surfaces had caused a light coating of rust in most areas. The 28-inch wide by 36-inch high slide gate built into the upstream face of the inlet as well as the anti-vortex steel plate across the top of the inlet, also appeared, except for some minor corrosion of the steel surfaces, to be in good condition. However, the slide gate was not operated to test its performance.

The outlet channels for the principal and emergency spillway channels were inspected. Through the crest section of the emergency spillway (see Photo 14), the channel, which crosses the roadway traversing the dam crest, was in satisfactory condition. However, beginning just downstream of the paved road (see Photo 15), erosion of the earthen invert has created two gullies (see Photos 17 and 18) up to about 8 feet in depth and 15 feet in width. At a point approximately 90 feet downstream of the crest, the two gullies converge (see Photo 16) to become a single channel. The outlet channel for the pipe spillway (see Photo 13) joins the emergency spillway outlet channel (see Photo 16) at a point about 50 feet downstream of the end of the pipe and approximately 100 feet downstream of the center of the dam. Erosion of the abutment at the outlet end of the pipe (see Photo 12) has allowed the pipe to project unsupported about 3 feet beyond the face of the bank. Downstream of the pipe, the channel is strewn with large stones and boulders on the order of 4 feet in diameter. Only minor erosion of the channel, which was mostly confined to the bank areas, was observed through this lower section.

With the exception of the slide gate at the drop inlet spillway structure, the inspection did not reveal the existence of an additional drawdown facility for Lake Lucern.

(3) Lake Innsbrook Dam. The visible portions of the upstream and downstream faces of the dam as well as the dam crest (see Photos 21 and 22) were inspected and found to be in sound condition, although erosion that appeared to be due to wave action or fluctuations of the lake level, had

created a near vertical bank approximately 24 inches high across the unprotected (no riprap) upstream face of the dam. No significant surface cracks (numerous minor cracks and small depressions were present in the bituminous roadway pavement on the dam crest), sloughing of the embankment slopes, or unusual settlement of the dam were noted. A hole believed to be an animal burrow (see Photo 32) was found in the downstream face of the dam near the right abutment. Several shallow gullies up to about 24 inches in depth (see Photo 33) that appeared to be a result of erosion by overland drainage were noticed at the junction of the downstream slope and the right abutment.

Except where worn away along a jeep trail near the right abutment, the grass on the dam slopes, a fescue, was about 24 inches high at the time of the inspection. Examination of a soil sample obtained from the downstream face of the dam indicated the material to be a silty lean clay (CL) of low-to-medium plasticity.

Seepage, as evidenced by a marshy area with willow trees and standing and flowing water (see Photo 31), was observed at the downstream toe of the dam opposite about station 3+00. Seepage flow at this location was estimated to be less than 1 gpm.

The 5-foot diameter steel drop inlet structure (see Photo 23) was examined and except for a light coating of rust on the unprotected steel surfaces, was found to be in satisfactory condition. The 30-inch wide by 54-inch high slide gate built into the upstream face of the inlet, with the exception of some minor corrosion, appeared to be in good condition although the gate was not operated to test its performance. The inlet did not have an anti-vortex plate. The downstream end of the 36-inch diameter steel outlet pipe (see Photo 24) was also examined and found to be in good condition, although a light coating of rust was apparent on the exposed exterior side. The interior of the pipe was protected by a bituminous coating about 3/16-inch in thickness.

The emergency spillway and spillway outlet channel were inspected and found to be in satisfactory condition. Through the crest area of the emergency spillway, (see Photo 25), the section is excavated to rock, and no

significant erosion was noticed. A large tree approximately 24 inches in diameter was lying in the channel at a point just downstream of the road that crosses the channel. The tree appeared to have fallen in the channel as a result of erosion of its base. The outlet channel for the 36-inch diameter spillway pipe joins the emergency spillway channel at a point approximately 60 feet downstream of the pipe. Some minor erosion of the earthen bank at the end of the pipe was noticed. Beyond the junction point, the outlet channel is irregular and follows a series of rock falls, (see Photo 26), to reach the valley floor nearly 120 feet downstream of the center of the dam. Across the valley, the channel, a section about 24 feet wide with 5-foot high banks, was fairly uniform. The channel joined the stream on which the dam was constructed at a location approximately 170 feet downstream of the center of the dam. A secondary channel that may have been caused by overflow of the main channel, although its point of origin could not be determined, also crossed the valley at a point about 65 feet downstream of the toe of the dam and upstream of the main channel. A pothole, approximately 2 feet in depth and about 7 feet in diameter (see Photo 34), was eroded into the invert at a point near the center of the channel.

The outlet section of the main lake drawdown facility (see Photo 27) that passes through the dam near the center of the structure was inspected and, except for some minor leakage as indicated herein, was found to be in satisfactory condition. The control valve was protected by a 55 gallon drum (see Photo 28) with the top removed for access to the valve. Straw was packed about the valve within the drum to prevent freezing. At a point approximately 23 feet downstream of the valve, the outlet, a 12-inch diameter steel pipe, had been extended by the addition of an 8-inch diameter polyvinylchloride (PVC) pipe. This section of PVC pipe continues for about 125 feet to a shallow ditch (see Photo 30) downstream of the dam. A 2.5-inch diameter valve (see Photo 29) located at the low point in the PVC piping is provided to drain the line. At the time of the inspection, water was draining from the end of the 2.5-inch valve at a rate of about 2 gpm. A pool of water about 15 feet wide and 16 feet in length existed within the original stream channel at the location of the drain valve. It could not be determined if all the water within the pool was due to leakage of the lake drawdown pipe and the seepage draining from the marshy area at the toe of the dam, or if seepage beneath the dam at the location of the pipe, was also contributing to the pool.

d. Appurtenant Structures. There are no appurtenant structures at these dams.

e. Downstream Channel. A section of channel, roughly 600 feet in length, lies downstream of the Lake Scheffborg Dam and upstream of Lake Lucern. Except for a culvert crossing the road just upstream of Lake Lucern, the channel is unimproved, irregular, and lined with trees. The Lake Lucern Dam spillway outlet channel joins the upstream end of Lake Innsbrook just downstream of the dam. The channel downstream of the Lake Innsbrook Dam is also unimproved although there are at least two road crossings within the estimated flood damage zone which extends five miles downstream of the dam. This section is also irregular and for the most part lined by trees. The tributary joins Charrette Creek at a point about one mile downstream of the Lake Innsbrook Dam.

f. Reservoir. The areas about Lake Scheffborg, Lake Lucern, and Lake Innsbrook are in various stages of residential development with many chalet style homes occupying the lots about the lakes. For the most part, the terrain surrounding the lakes has been maintained in a native state covered with trees. Only occasional minor erosion of the lake banks was noticed, and was most apparent along the north side of Lake Scheffborg. The amount of sedimentation within the lakes could not be determined during the inspection; however, because of the vegetation covering the surrounding areas and the fact that the upstream lakes will serve as retention basins for stream carried sediment, it is not expected to be significant.

## 3.2 EVALUATION

The deficiencies observed during the inspection and reported herein as well as in Section 7, paragraph 7.2b, are not considerd of major consequence to warrant immediate remedial action.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

The spillways for the Lake Scheffborg, Lake Lucern, and Lake Innsbrook Dams are uncontrolled. Each lake surface level is governed by precipitaton runoff, evaporation, seepage, and the capacities of the uncontrolled spillways.

### 4.2 MAINTENANCE OF DAM

With the exception of the items noted in Section 3, paragraph 3.1c, the Lake Lucern and the Lake Innsbrook Dams appear to be reasonably well maintained. Judging by the high grass and the many small trees present on the Lake Scheffborg Dam as well as the numerous large trees blocking the spillway outlet channel, it appears that maintenance of this dam has been somewhat neglected.

According to Mr. Steven Woebbe, the dams are inspected by the Owner's employees twice a year; trees are removed from the dam slopes; however, the grass on the slopes is not cut.

### 4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

With the exception of the slide gates located in the drop inlet structures at the Lake Lucern and the Lake Innsbrook Dams, and the lake drawdown valves at the Lake Scheffborg and the Lake Innsbrook Dams, no outlet facilities requiring operation exist at these three dams. Both slide gates as well as the valve at the Lake Innsbrook Dam appeared to be in satisfactory condition, although the valve was experiencing some minor leakage. The valve at the Lake Scheffborg Dam was inaccessible and could not be inspected; however, some leakage at the end of the outlet pipe was noted.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam failure warning system.

## 4.5 EVALUATION

It is recommended that maintenance of the dams also include removal of trees and periodic cutting of grass on the embankment. Measures should also be taken to prevent further erosion of the dams and spillways, and the spillway outlet channels should be cleared of fallen trees. It is also recommended that a detailed inspection of each dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available.

b. Experience Data. There are six lakes of hydraulic/hydrologic significance located upstream of the three lakes comprising the Innsbrook group of lakes. Of the six lakes, two (Lake A and Lake 30512) are located upstream of Lake Scheffborg; one (Lake B) is located upstream of Lake Lucern; and three (Lake 30520, Lake C and Lake 31443) are located upstream of Lake Innsbrook. Phase I inspection reports of Dams 30512 and 31443 were prepared by Horner & Shifrin, Inc., for the St. Louis District, Corps of Engineers, in July and August of 1980. The relative location of the six lakes, as well as the Innsbrook lakes (Lakes Scheffborg, Lucern and Innsbrook) are shown on Plate 3.

The drainage areas and lake surface areas for the nine lakes were developed from the 1972 USGS Wright City, Missouri, Quadrangle Map. The proportions and dimensions of the spillways and dams were determined from surveys made during July and August of 1980. Records of rainfall, streamflow, or flood data for the watershed were not available.

Due to the fact that the watersheds for these reservoirs are comparatively small, and since there are no histories of excessive reservoir leakage that would adversely affect the normal operating level of the lakes, the lake levels were assumed to be at normal pool as a result of antecedent storms prior to occurrence of the PMF and the probabilistic storm.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of only the Lake Scheffborg Dam occur, extends one mile downstream of the dam. The Lake Lucern Dam is located within this potential damage zone. The estimated flood damage zone, should failure of only the Lake Lucern Dam occur, extends six miles downstream of the dam. The Lake Innsbrook Dam is located within this potential damage zone. The estimated flood damage zone, should failure of only the Lake Innsbrook Dam

occur, extends five miles downstream of the dam. No information was furnished regarding the length of the damage zone should successive failure of all three dams occur.

c. Visual Observations.

(1) Lake Scheffborg Dam.

(a) The spillway, a broad crested trapezoidal section excavated to a layer of natural rock, is located at the left, or east abutment of the dam.

(b) The spillway outlet channel, an excavated trapezoidal section, directs flow away from the dam and discharges into an unimproved channel that joins the original stream about 250 feet downstream of the dam. The channel is severely eroded through the exit section.

(c) A 15-inch diameter steel pipe with the control valve located near the toe of the dam is provided for lake drawdown.

(2) Lake Lucern Dam.

(a) The dam has both a principal and an emergency spillway. The principal spillway, located at the left, or east abutment, consists of a 60-inch diameter steel drop inlet with a 30-inch diameter steel outlet pipe. The emergency spillway, a broad-crested, dish-shaped excavated earth section, is also located at the left abutment of the dam.

(b) The principal spillway outlet channel, an excavated irregular and extensively eroded earth section, directs flow away from the dam and discharges into Lake Innsbrook about 200 feet downstream of the dam. The emergency spillway outlet channel joins the principal spillway outlet channel about 160 feet downstream of the dam.

(c) A steel slide gate, installed in the wall of the drop inlet structure about 36 inches below the top of the inlet, is provided to permit partial lake drawdown.

(3) Lake Innsbrook Dam.

(a) The dam has both a principal and an emergency spillway. The principal spillway, located near the left, or east, abutment of the dam, consists of a 60-inch diameter steel drop inlet with a 36-inch diameter steel outlet pipe. The emergency spillway, a trapezoidal excavated earth section with a rock bottom, is also located at the left abutment.

(b) The principal spillway outlet channel, an irregular excavated channel, joins the original stream about 300 feet downstream of the dam. The emergency spillway outlet channel, a trapezoidal excavated earth section, is crossed by the paved roadway which traverses the dam about 150 feet downstream of the dam. About 50 feet below the road crossing, the emergency spillway outlet channel joins the principal spillway outlet channel.

(c) A steel slide gate installed in the wall of the drop inlet structure about 54 inches below the top of the inlet, is provided to facilitate partial lake drawdown. A 12-inch diameter steel pipe with its control valve located near the toe of the dam is provided for lake drawdown. Addition of an 8-inch PVC pipe has extended the outlet about 100 feet beyond the toe of the dam.

d. Overtopping Potential. In the analyses of overtopping potential of the dams in the Innsbrook group of lakes, recognition was made of the various upstream impoundments. In these analyses and in accordance with the hydraulic/hydrologic standards established by the St. Louis District, Corps of Engineers, it was assumed that, while the dams of the upstream lakes might be overtopped, failure of their embankments would not occur as long as their spillway capacities before overtopping equalled or exceeded 50 percent of the probable maximum flood inflow. Accordingly, for those upstream dams whose spillway capacities before overtopping were less than 50 percent of the probable maximum flood inflow, it was assumed in the PMF overtopping analyses that dam breaching would occur within one hour after the occurrence of dam overtopping.

For the analysis of the 1 percent probability flood, it was found that the spillways for Dams A and C were not adequate to pass the outflow from the 1 percent probability flood without overtopping. However, for each dam the depth of overtopping was relatively small (0.14 feet for Dam A and 0.35 feet for Dam C) and it was assumed that these dams would not fail during the occurrence of the 1 percent probability flood.

(1) Lake Scheffborg Dam. In the analyses, upstream Dam A (with spillway capacity of about 13 percent of the probable maximum flood inflow) was assumed to breach upon overtopping, and upstream Dam 30512 (with spillway capacity of about 50 percent of the PMF inflow) was assumed not to breach after overtopping.

The Lake Scheffborg spillway is inadequate to pass the probable maximum flood, or 1/2 the probable maximum flood, without overtopping the dam. The spillway is adequate, however, to pass the 1 percent probability (100-year frequency) flood without overtopping the dam. The results of the dam overtopping analyses are as follows:

(Note: The data appearing in the following tables has been extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

| Ratio of PMF | Q-Peak Outflow (cfs) | Max. Lake W.S. Elev. | Max. Depth (Ft.) of Flow over Dam (Elev. 728.4) | Duration of Overtopping of Dam (Hours) |
|---|---|---|---|---|
| 0.50 | 3,796 | 730.0 | 1.6 | 2.5 |
| 1.00 | 7,859 | 731.3 | 2.9 | 6.0 |
| 1% Probability Flood | 801 | 727.3 | 0.0 | 0.0 |

Elevation 728.4 was found to be the lowest point in the dam crest. The flow safely passing the spillway just prior to overtopping amounts to approximately 1,300 cfs, which is the routed outflow corresponding to about 18

percent of the probable maximum flood inflow. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 2.9 feet and overtopping will extend across the entire length of the dam.

(2) Lake Lucern Dam. In the analyses, upstream Dam B (with spillway capacity of about 89 percent of the PMF inflow) was assumed not to breach after dam overtopping, and upstream Lake Scheffborg Dam (with spillway capacity of about 18 percent of the PMF inflow) was assumed to breach after overtopping.

The Lake Lucern spillways are inadequate to pass the probable maximum flood, or 1/2 the probable maximum flood, without overtopping the dam. The spillways are adequate, however, to pass the 1 percent probability (100-year frequency) flood without overtopping the dam. The results of the dam overtopping analyses are as follows:

| Ratio of PMF | Q-Peak Outflow (cfs) | Max. Lake W.S. Elev. | Max. Depth (Ft.) of Flow over Dam (Elev. 697.2) | Duration of Overtopping of Dam (Hours) |
|---|---|---|---|---|
| 0.50 | 7,416 | 698.8 | 1.6 | 3.5 |
| 1.00 | 14,701 | 700.1 | 2.9 | 6.2 |
| 1% Probability Flood | 1,408 | 696.3 | 0.0 | 0.0 |

Elevation 697.2 was found to be the lowest point in the dam crest. The flow safely passing the spillways just prior to overtopping amounts to approximately 2,465 cfs, which is the routed outflow corresponding to about 20 percent of the probable maximum flood inflow. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 2.9 feet and overtopping will extend across the entire length of the dam.

(3) Lake Innsbrook Dam. In the analyses, upstream Dam 30520 (with spillway capacity of about 44 percent of the PMF inflow), upstream Dam C (with spillway capacity of about 7 percent of the PMF inflow), upstream Dam 31443 (with spillway capacity of about 14 percent of the PMF inflow), and upstream

Lake Lucern Dam (with spillway capacity of about 20 percent of the PMF inflow) were all assumed to breach after overtopping.

The Lake Innsbrook spillways are inadequate to pass the probable maximum flood, or 1/2 the probable maximum flood, without overtopping the dam. The spillways are adequate, however, to pass the 1 percent probability (100-year frequency) flood without overtopping the dam. The results of the overtopping analyses are as follows:

| Ratio of PMF | Q-Peak Outflow (cfs) | Max. Lake W.S. Elev. | Max. Depth (Ft.) of Flow over Dam (Elev. 678.7) | Duration of Overtopping of Dam (Hours) |
|---|---|---|---|---|
| 0.50 | 12,543 | 682.5 | 3.8 | 7.6 |
| 1.00 | 24,060 | 684.7 | 6.0 | 10.9 |
| 1% Probability Flood | 600 | 677.0 | 0.0 | 0.0 |

Elevation 678.7 was found to be the lowest point in the dam crest. The flow safely passing the spillways just prior to overtopping amounts to approximately 1,088 cfs, which is the routed outflow corresponding to about 14 percent of the probable maximum flood inflow. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 6.0 feet and overtopping will extend across the entire length of the dam.

e. Evaluation. Examination of the surficial material of each of these dams indicated it to be a silty lean clay of low-to-medium plasticity. Experience indicates that this type of material, under certain conditions, such as high velocity flow, can be very erodible. An example of such erosion exists within the spillway outlet channels for the Lake Scheffborg and Lake Lucern Dams. Such a condition will exist during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition where the depth of flow over the dam crests and the duration of flow over the dams are appreciable, damage by erosion to the crest and downstream face of each of these dams is expected. The extent of these damages is not predictable within the scope of these investigations; however, there is a

possibility that they could result in failure by erosion of these dams. Therefore, the assumption that failure of the Lake Scheffborg and Lake Lucern Dams by breaching when overtopped by the PMF is considered to be realistic and reasonable. It also follows that failure of the Lake Innsbrook Dam could also occur when overtopped by the PMF. A similar condition, although not quite as severe, also exists for these dams during the 1/2 PMF event. The fact that the crests of the Lake Lucern and Lake Innsbrook Dams are traversed by paved roadways may offer some degree of protection in the event of overtopping of these dams.

f. Reference. Procedures and data for determining the probable maximum flood, the 1 percent probability flood, and the discharge rating curves for flow passing the spillways for the three dams are presented on pages B-1 through B-5 of the Appendix.

Listing of the HEC-1 (Dam Safety Version) input data for the probable maximum flood; computer output data, including unit hydrograph ordinates and tabulation of PMF rainfall, loss and inflow data for Lake A; tabulations of lake surface area, elevation and storage volume, and tabulations titled "Summary of Dam Safety Analysis" for the PMF for Lake Scheffborg and the lakes upstream thereof are shown on pages B-6 through B-15.

Listing of computer input data for the PMF; computer output data including tabulations of the lake surface area and tabulations titled "Summary of Dam Safety Analysis" for the PMF for Lake Lucern and the upstream lakes are shown on pages B-16 through B-23. The same data for the PMF for Lake Innsbrook and the upstream lakes are shown on pages B-24 through B-38.

Listing of computer input data for the 1 percent probability flood, and computer output data including tabulations titled "Summary of Dam Safety Analysis" for Lake Innsbrook and the upstream lakes are shown on pages B-39 through B-51.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which adversely affect the structural stability of the dams are discussed in Section 3, paragraph 3.1c.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dams are known to exist. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. With the exception of the slide gates located in the drop inlet spillway structures at the Lake Lucern and the Lake Innsbrook Dams, and the lake drawdown valves at the Lake Scheffborg and the Lake Innsbrook Dams, no appurtenant structures or facilities requiring operation exist at these dams. According to Mr. Steven Woebbe, a representative of the Owner, no records are kept of lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to Mr. Woebbe and except as noted herein, no post construction changes have been made or have occurred which would affect the structural stability of the dams. It was reported that the valve on the lake drawdown pipe at the Lake Scheffborg Dam was replaced by the former owner because of excessive leakage and that the PVC section at the Lake Innsbrook drawdown pipe was added during the winter of 1979-1980.

e. Seismic Stability. The dams are located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of the sizes being investigated provided that static stability conditions are

satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading be applied in any stability analyses performed for these dams.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety.

(1) Overtopping.

(a) Lake Scheffborg Dam. A hydraulic analysis indicated that the spillway is capable of passing lake outflow of about 1,300 cfs without the level of the lake exceeding the low point of the dam crest. A hydrologic analysis of the runoff from the lake watershed area as discussed in Section 5, paragraph 5.1d, indicates that for a storm of probable maximum flood magnitude, the lake outflow would be about 7,859 cfs, and that for the one percent probability (100-year frequency) flood, the lake outflow would be approximately 801 cfs.

(b) Lake Lucern Dam. A hydraulic analysis indicated that the spillways (principal plus emergency) are capable of passing lake outflow of about 2,465 cfs without the level of the lake exceeding the low point of the dam crest. A hydrologic analysis of the runoff from the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that, for a storm of probable maximum flood magnitude, the lake outflow would be about 14,701 cfs, and that for the one percent probability (100-year frequency) flood, the lake outflow would be approximately 1,408 cfs.

(c) Lake Innsbrook Dam. A hydraulic analysis indicated that the spillways (principal plus emergency) are capable of passing lake outflow of about 1,088 cfs without the level of the lake exceeding the low point of the dam crest. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff of probable maximum flood magnitude, the lake outflow would be about 24,060 cfs, and that for the one percent probability (100-year frequency) flood, the lake outflow would be about 600 cfs.

(2) Seepage and Stability Analysis. Seepage and stability analyses of the dams were not available for review, and therefore, no judgment could be made with respect to the structural stability of the dams.

(3) Visual Observations. Several items were noticed during the inspection that could adversely affect the safety of the dams. These items which were apparent at one or more of the three dams inspected, include the lack of adequate slope protection to prevent erosion of the upstream face of the dam, dam seepage, standing water at the downstream toe of the dam, trees on the embankment, animal burrows in the embankment, surface erosion, fallen trees within the spillway outlet channel, erosion within the spillway outlet channel, and tall grass on the embankment slopes. The extent and location of these items is discussed in Section 3, paragraph 3.1c.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacity of the spillways were based on a hydraulic/-hydrologic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The remedial measures recommended in paragraph 7.2 for the items concerning the safety of the dams noted in paragraph 7.1a should be accomplished within a reasonable time. The item recommended in paragraph 7.2a concerning provision of additional spillway capacity should be pursued on a high priority basis.

d. Necessity for Phase II and Other Studies. Based on the results of the Phase I inspection, a Phase II investigation is not recommended. There is a possibility that although improvements to the spillways at the Innsbrook dams are made, unless similar spillway and/or height of dam improvements are made to the dams upstream of the Innsbrook group, conditions may still exist which could impair the safety of these, i.e. Lake Scheffborg, Lake Lucern, and Lake Innsbrook, dams. The Owner needs to address the situation assuming improvements to the upstream dams are not made. It is recommended that Phase

I investigations of Dams A, B, and 30512 be made, since failure of any one of these dams could jeopardize the downstream Innsbrook Dams. Since Dam C does not meet the minimum criteria for height of dam and storage capacity as prescribed in the recommended guidelines, a Phase I investigation of this dam is not recommended.

e. Seismic Stability. The dams are located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of the sizes being investigated provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading be applied in any stability analyses performed for these dams.

## 7.2 REMEDIAL MEASURES

a. Recommendations. The following actions, applicable to each dam, are recommended.

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased in order to pass lake outflow resulting from a storm of probable maximum flood magnitude, which is the recommended spillway design flood. In any event, the spillway should be protected against erosion.

(2) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams.

b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

(1) Provide some form of protection other than grass for the upstream face of each dam at and above the normal waterline in order to prevent erosion. A grass covered slope is not considered adequate protection to prevent erosion of the embankment by wave action or by a fluctuating lake level. The downstream toe at the Lake Lucern Dam should also be protected to prevent erosion. Loss of material by erosion can impair the structural stability of the dam.

(2) Provide some means of controlling seepage evident at the downstream toe of slope at the Lake Lucern and Lake Innsbrook Dams. Uncontolled seepage can lead to a piping condition (progressive internal erosion) that could result in failure of the dam.

(3) Drain the pools of standing water adjacent to the downstream toe of the Lake Scheffborg and Lake Innsbrook Dams and restore the eroded areas adjacent to the dams. Saturation of the soil adjacent to the dam by standing water can weaken the strength of the material and reduce its capacity to provide foundation support, a condition considered detrimental to the stability of the dam. It is also recommended that the valves on the lake drawdown pipes be repaired to prevent leakage and that positive drainage of the areas adjacent to the dams be provided..

(4) Remove the trees from the Lake Scheffborg and Lake Lucern Dams and restore the embankment at the holes believed to be old animal burrows at all three dams. Also maintain the height of the grass on the dams such that it will not provide cover for burrowing animals or hinder inspection of the dams. Tree roots and animal burrows can provide passageways for lake seepage that could develop into a piping condition.

(5) Restore the eroded areas at the junction of the downstream slope and the right abutment of the Lake Innsbrook Dam. Loss of material by erosion can impair the structural stability of the dams.

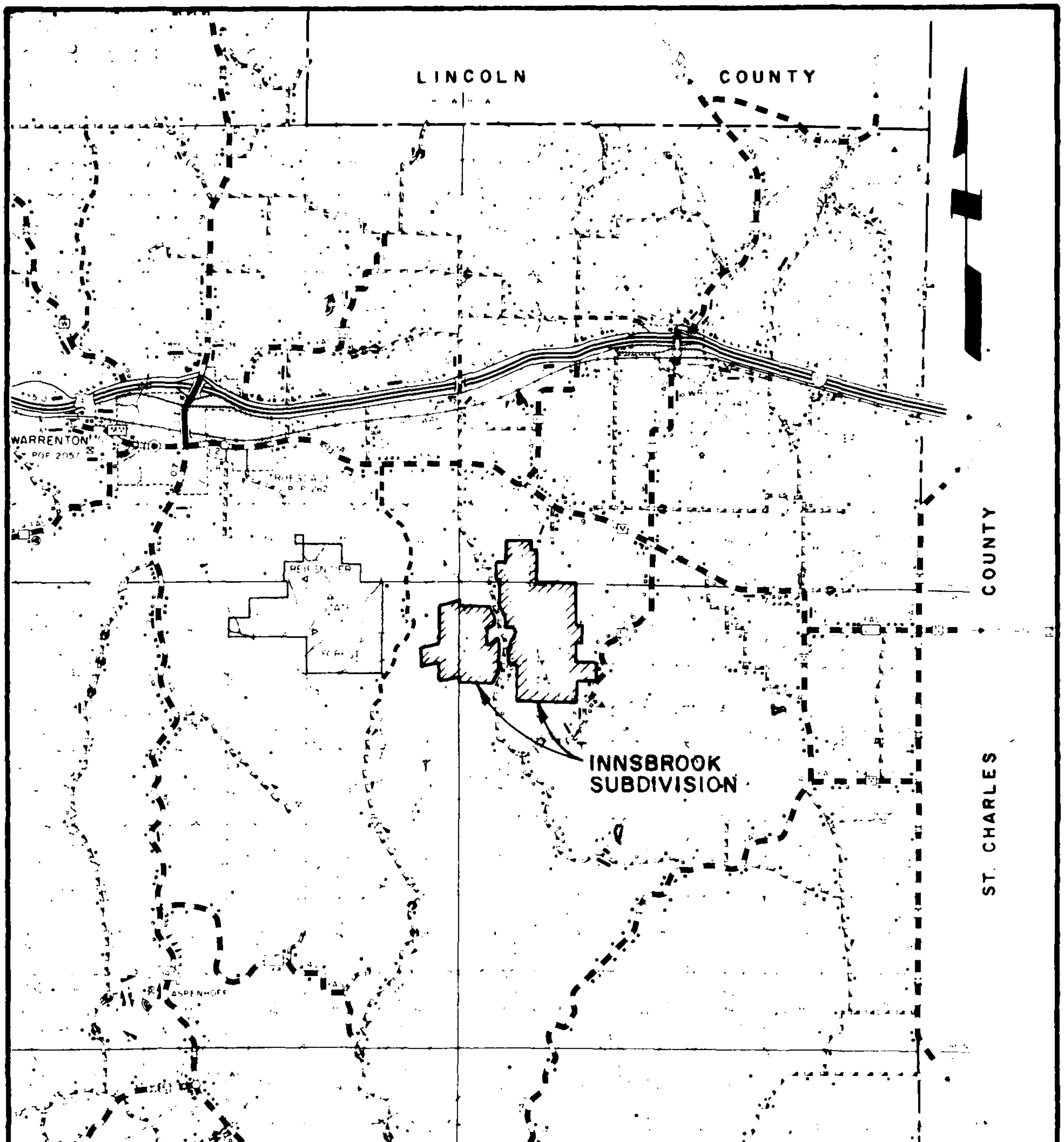
(6) Remove the large fallen trees from within the spillway outlet channels for the Lake Scheffborg and the Lake Inns'rook Dams. Obstructions such as large trees can impede flow within the channel reducing its outlet

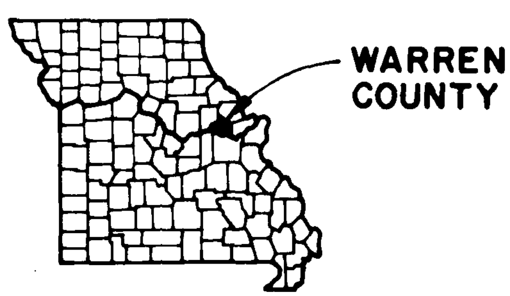
capacity which could result in channel overflow impinging upon the dam and erosion of the embankment.

(7) Monitor the spillway outlet channels for evidence of instability and erosion that could cause the channels to encroach upon the dams or become blocked.

(8) Provide maintenance of all areas of each dam and spillway, on a regularly scheduled basis in order to insure that these features are in satisfactory condition.

(9) A detailed inspection of each dam should be instituted on a regularly scheduled basis by a qualified engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.




LOCATION MAP

INNSBROOK SUBDIVISION

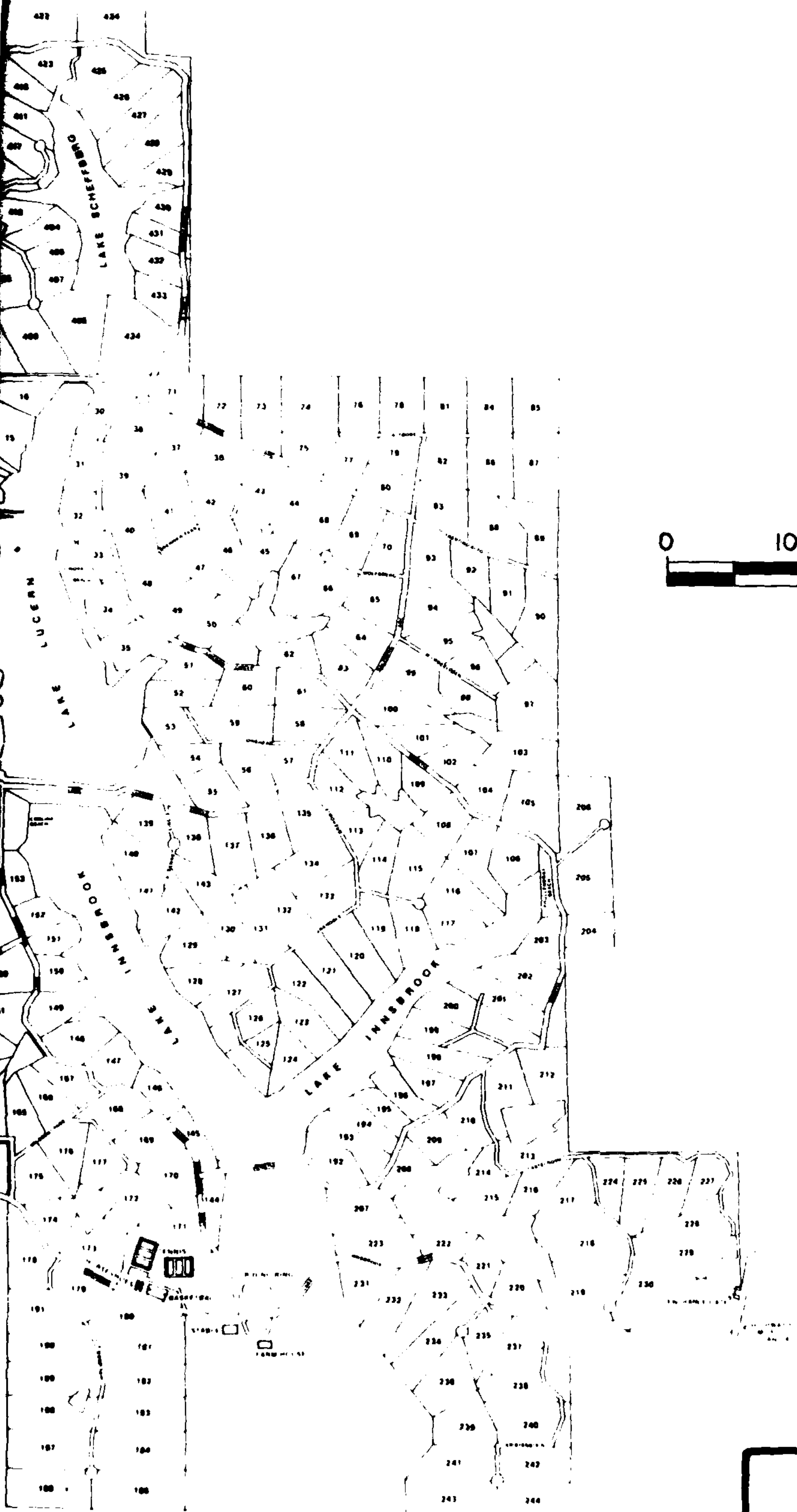
1 0 1 2 3 4

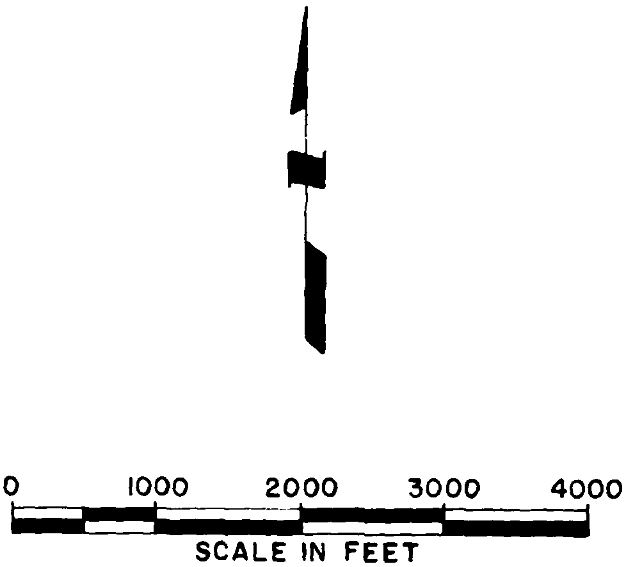
SCALE (MILES)

REGIONAL VICINITY MAP

PLATE I

# Innsbrook

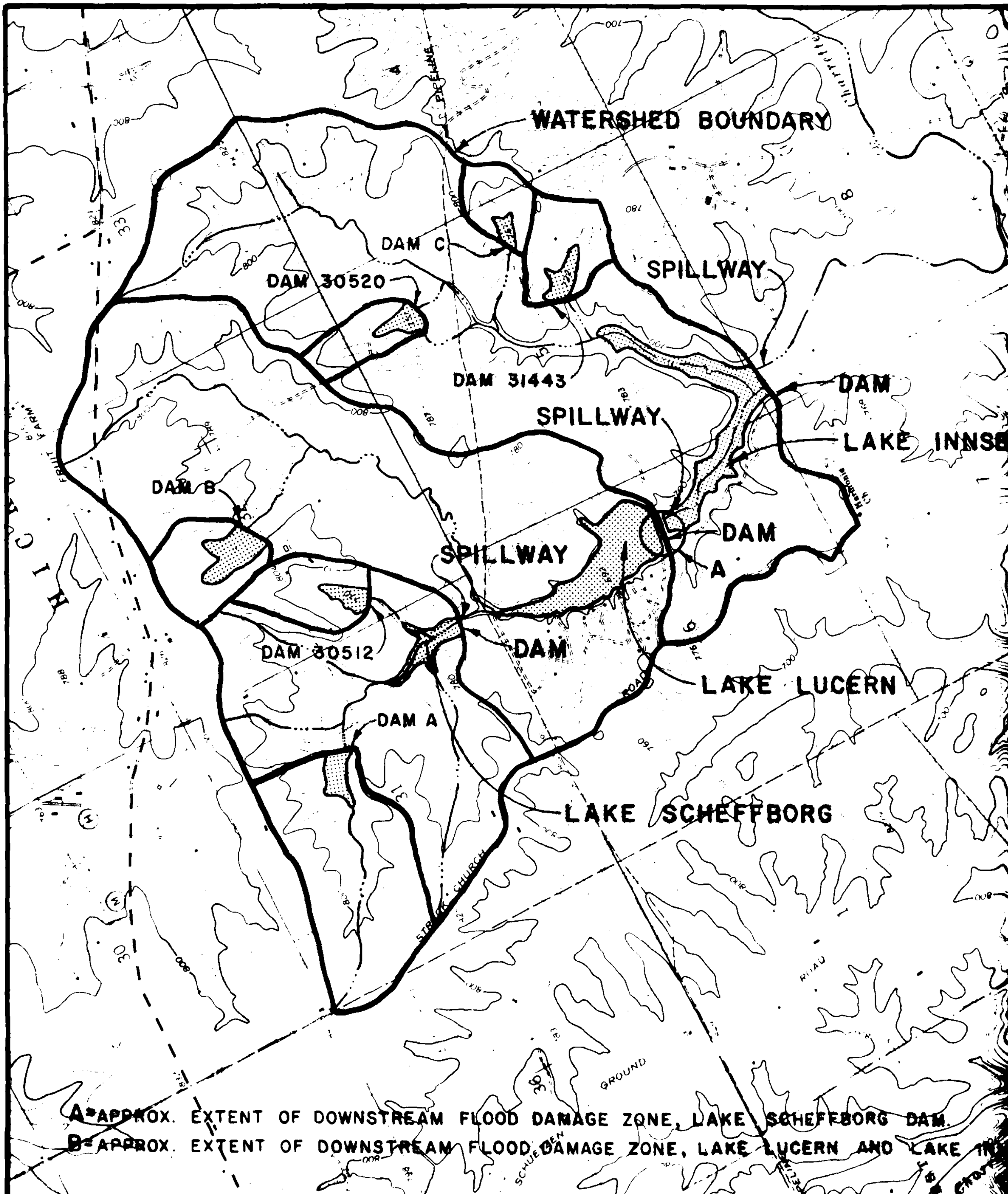


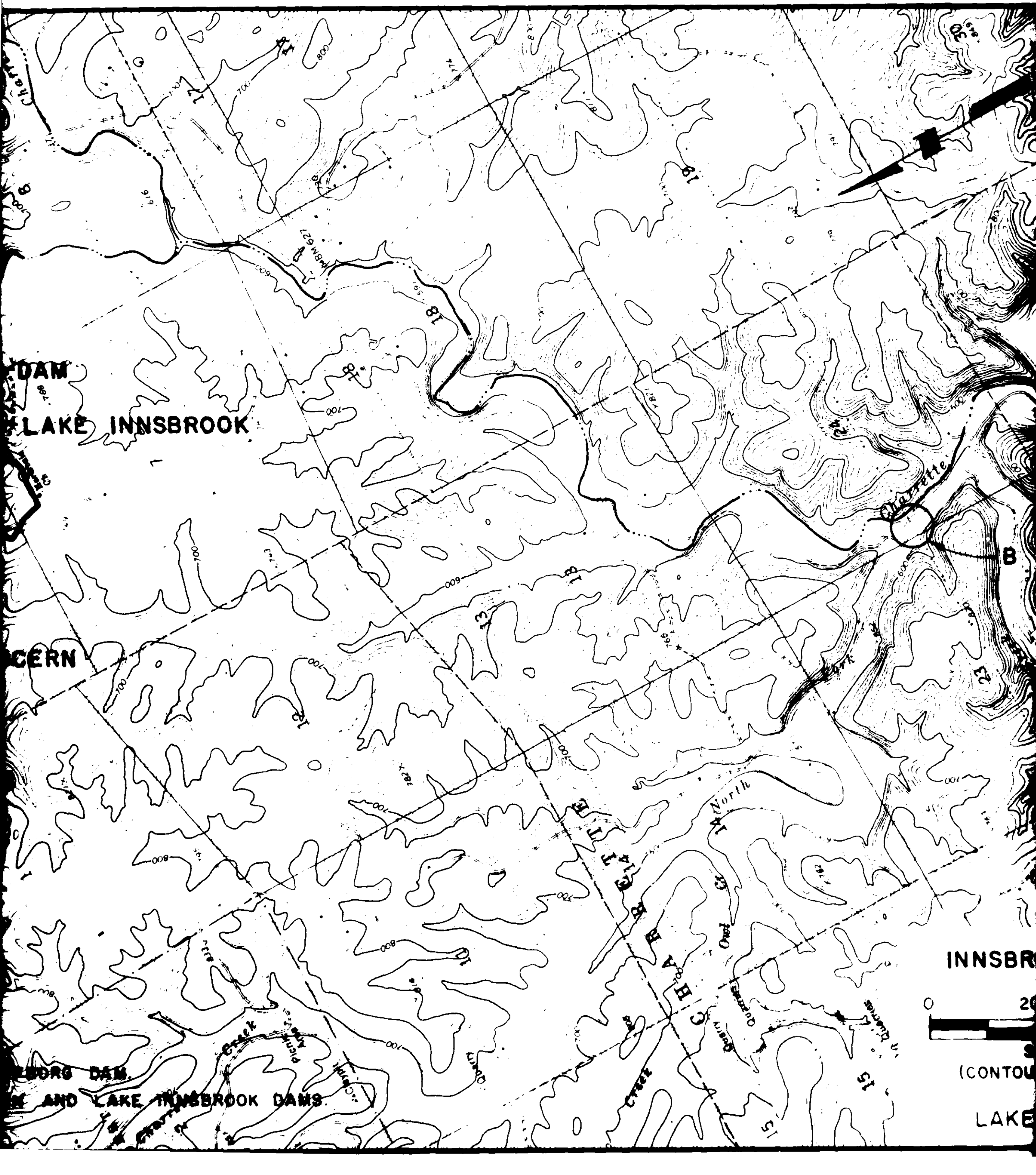

SUBDIVISION PLAT
COURTESY OF
ASPENHOF CORP.

**INNSBROOK**

**SUBDIVISION PLAT**



WATERSHED BOUNDARY
DAM C
SPILLWAY
DAM 30520
DAM 31443
DAM
SPILLWAY
LAKE INNSE
DAM B
DAM
A
SPILLWAY
DAM 30512
DAM
LAKE LUCERN
DAM A
LAKE SCHEFFBORG
PIPELINE
FRUIT FARM
ROAD
GROUND
A=APPROX. EXTENT OF DOWNSTREAM FLOOD DAMAGE ZONE, LAKE SCHEFFBORG DAM.
B=APPROX. EXTENT OF DOWNSTREAM FLOOD DAMAGE ZONE, LAKE LUCERN AND LAKE IN


DAM
LAKE INNSBROOK
CERN
INNSBR
(CONTOU
LAKE
AND LAKE INNSBROOK DAMS
CHARRETTE
North
Creek

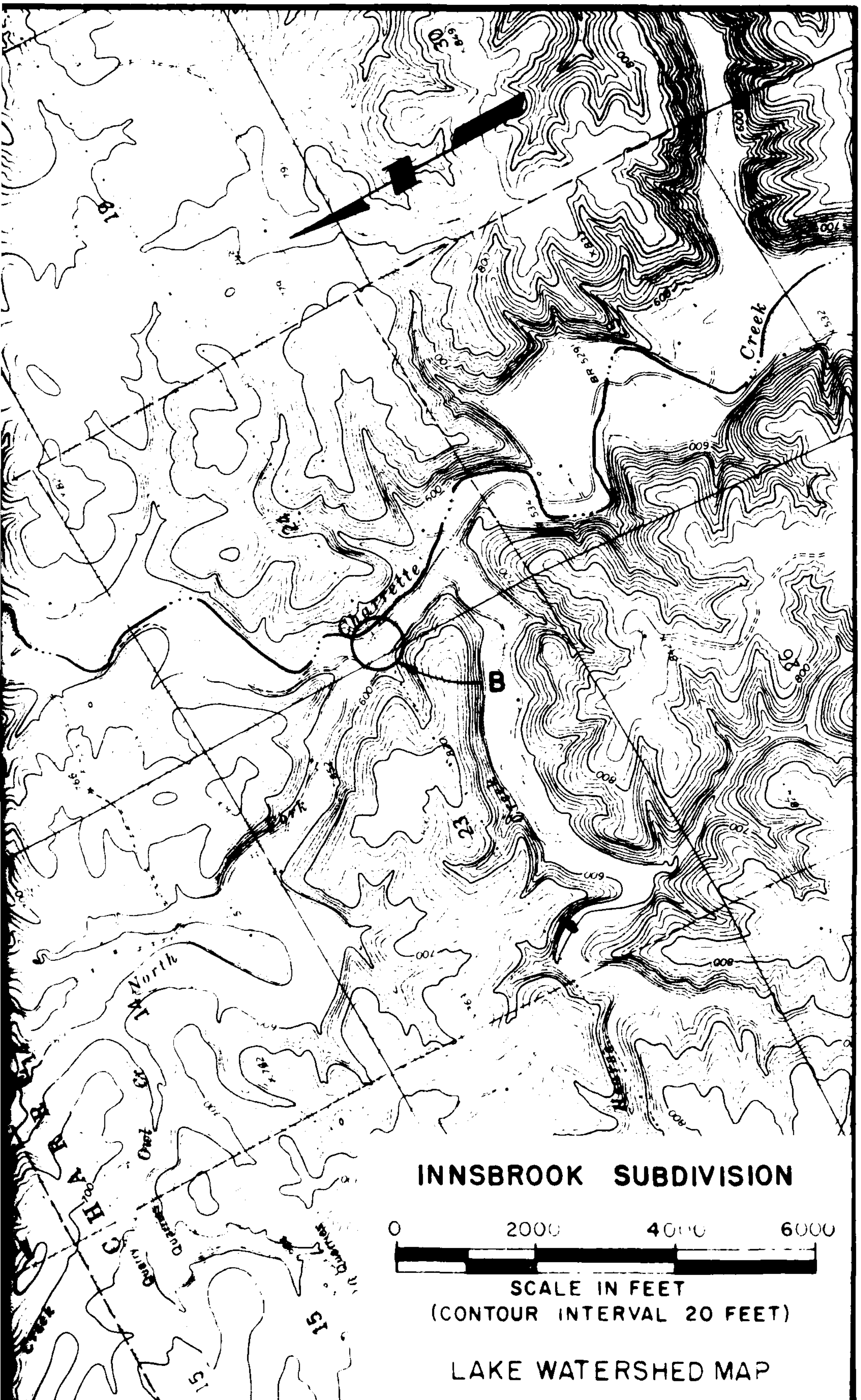
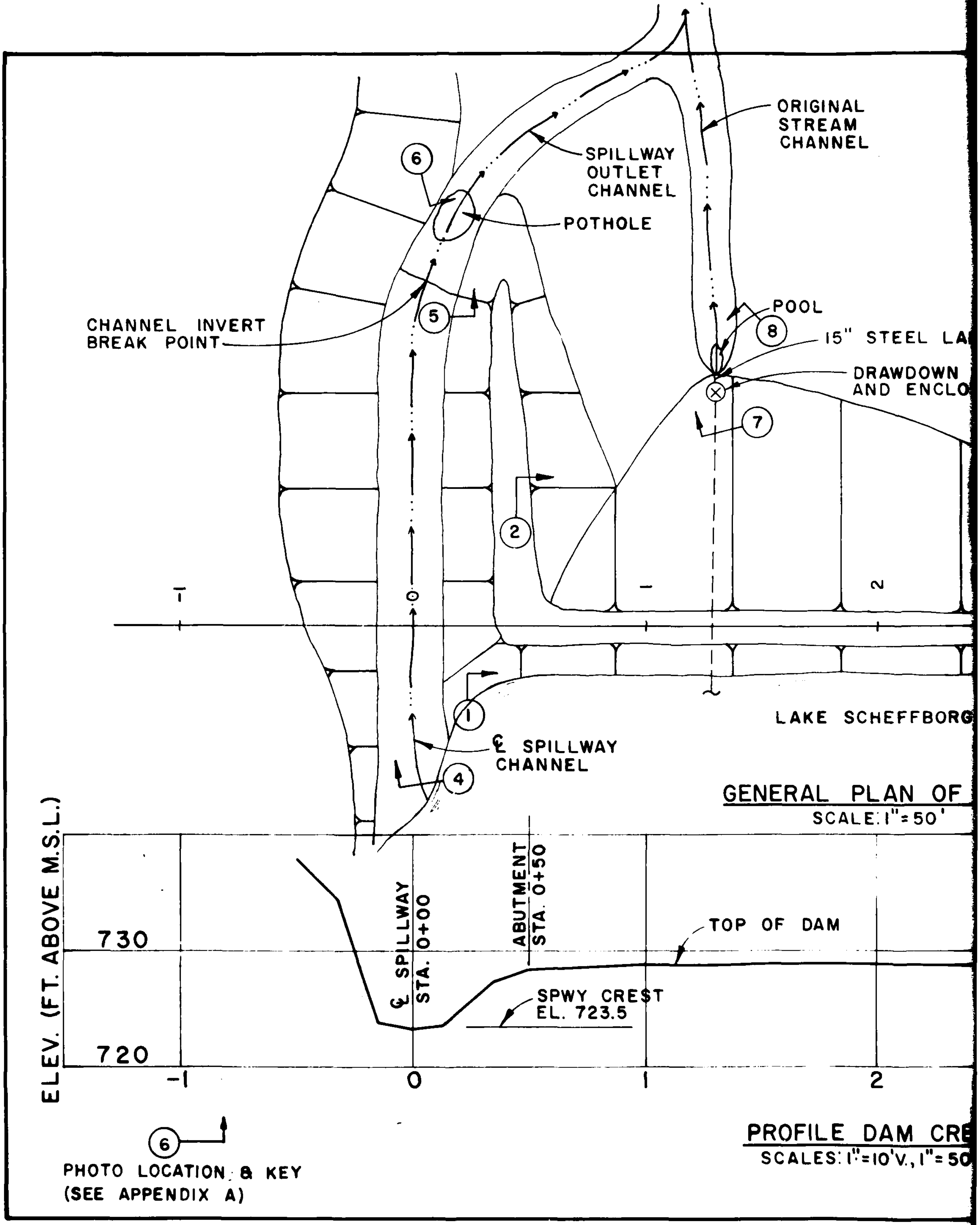
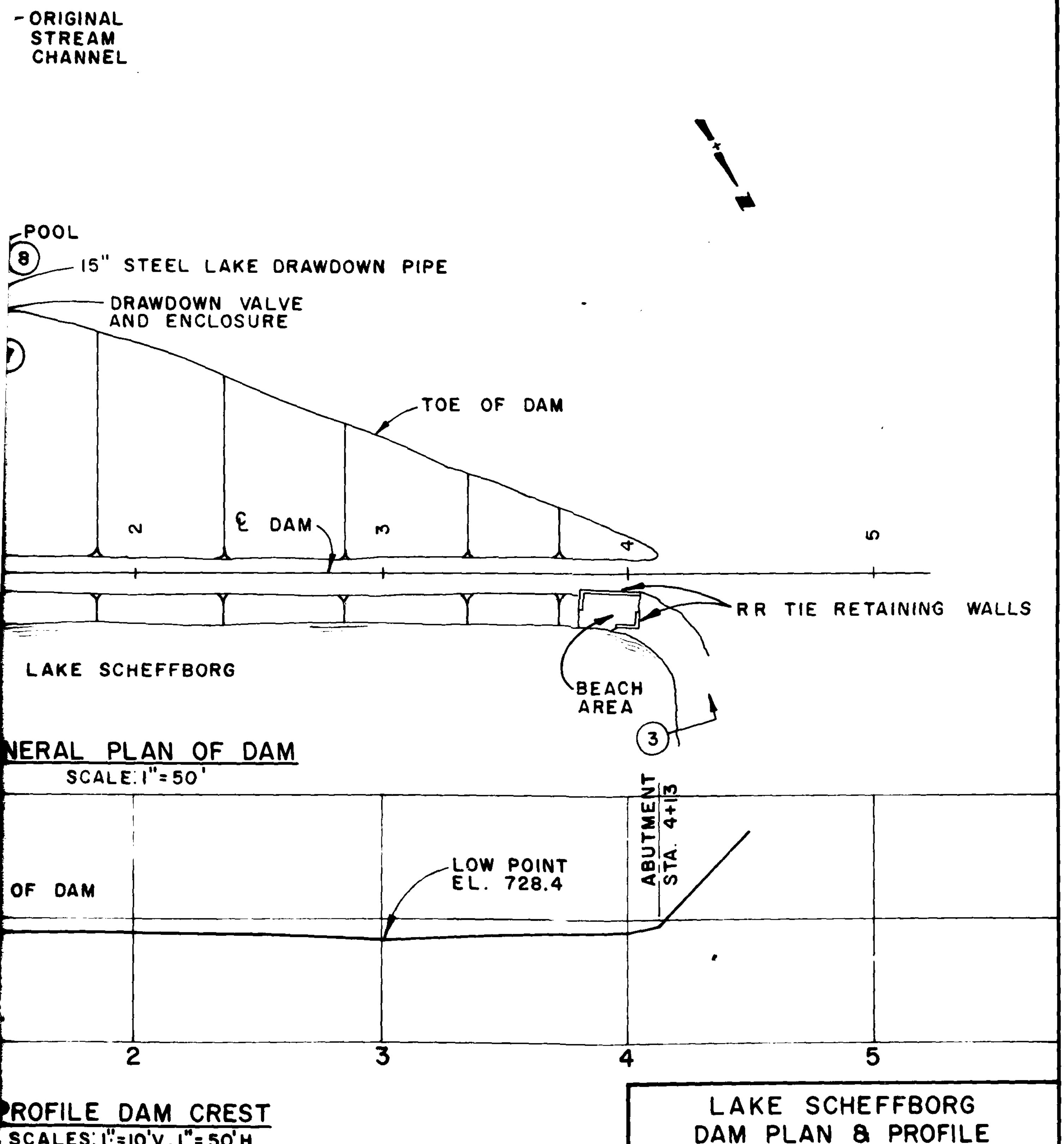

INNSBROOK SUBDIVISION
0 2000 4000 6000
SCALE IN FEET
(CONTOUR INTERVAL 20 FEET)
LAKE WATERSHED MAP
Creek
B
North
Fork
Cr.
600
700
800
19
23
24
26
30
15



PLATE 3



ORIGINAL STREAM CHANNEL
SPILLWAY OUTLET CHANNEL
POTHOLE
CHANNEL INVERT BREAK POINT
POOL
15" STEEL LA
DRAWDOWN AND ENCLO
LAKE SCHEFFBORG
℄ SPILLWAY CHANNEL
GENERAL PLAN OF
SCALE: 1"=50'
ELEV. (FT. ABOVE M.S.L.)
730
720
-1
0
1
2
℄ SPILLWAY STA. 0+00
ABUTMENT STA. 0+50
TOP OF DAM
SPWY CREST EL. 723.5
PROFILE DAM CRE
SCALES: 1"=10'V., 1"=50
PHOTO LOCATION & KEY (SEE APPENDIX A)

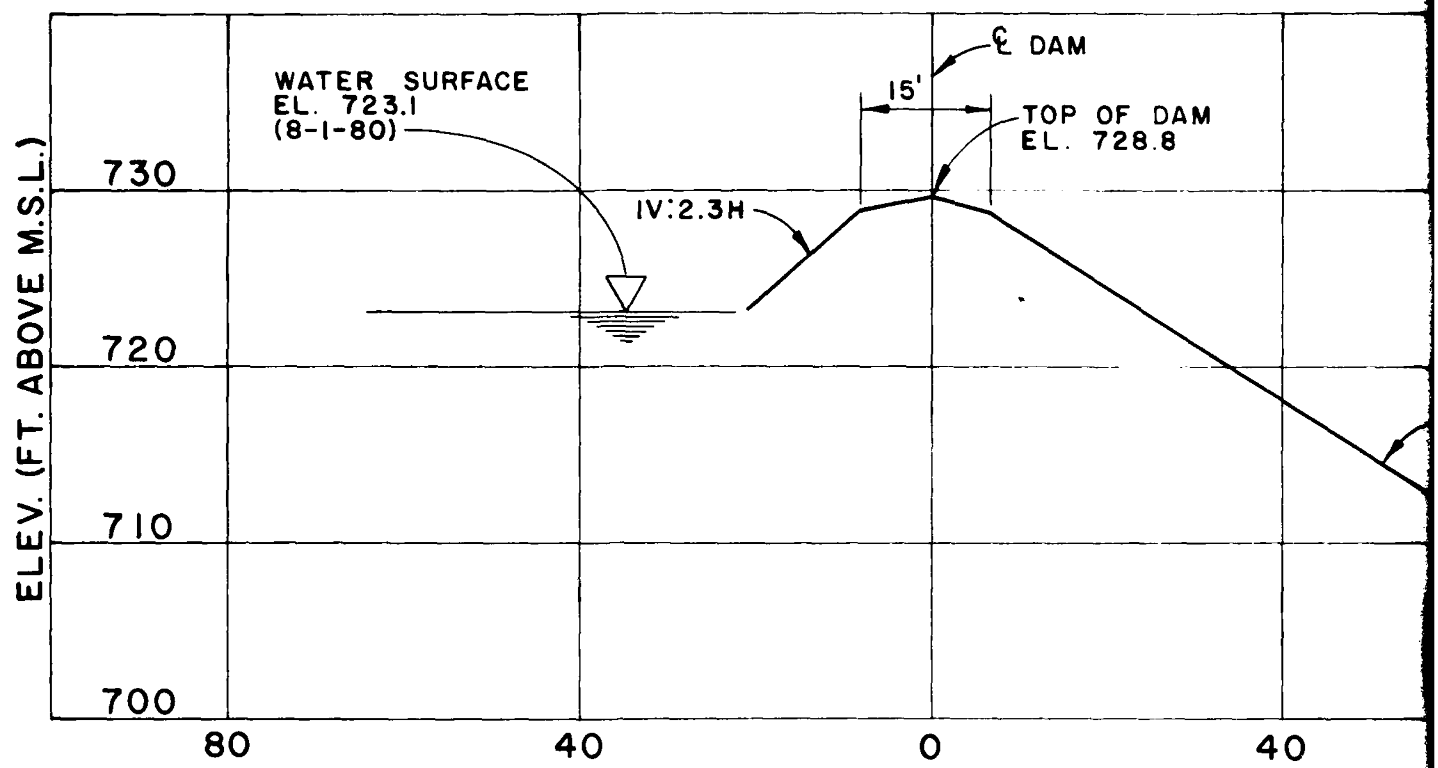



LAKE SCHEFFBORG
DAM PLAN & PROFILE

Horner & Shifrin, Inc. August 1980

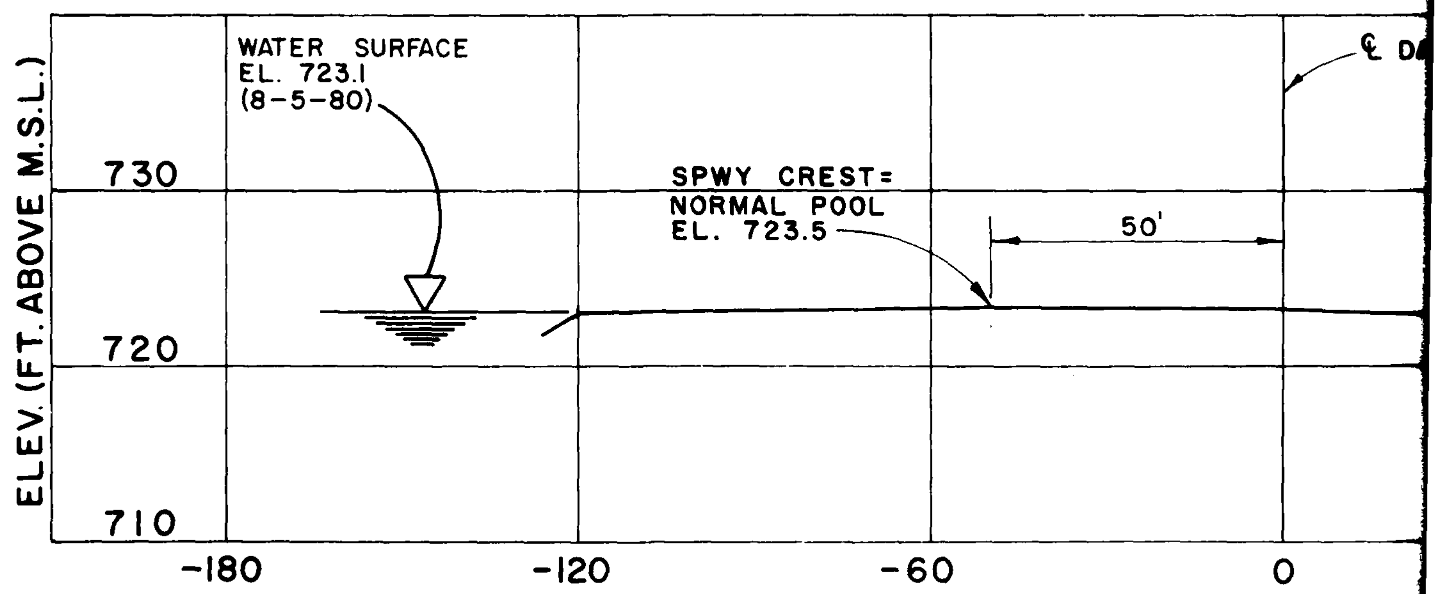
PLATE 4

1 2



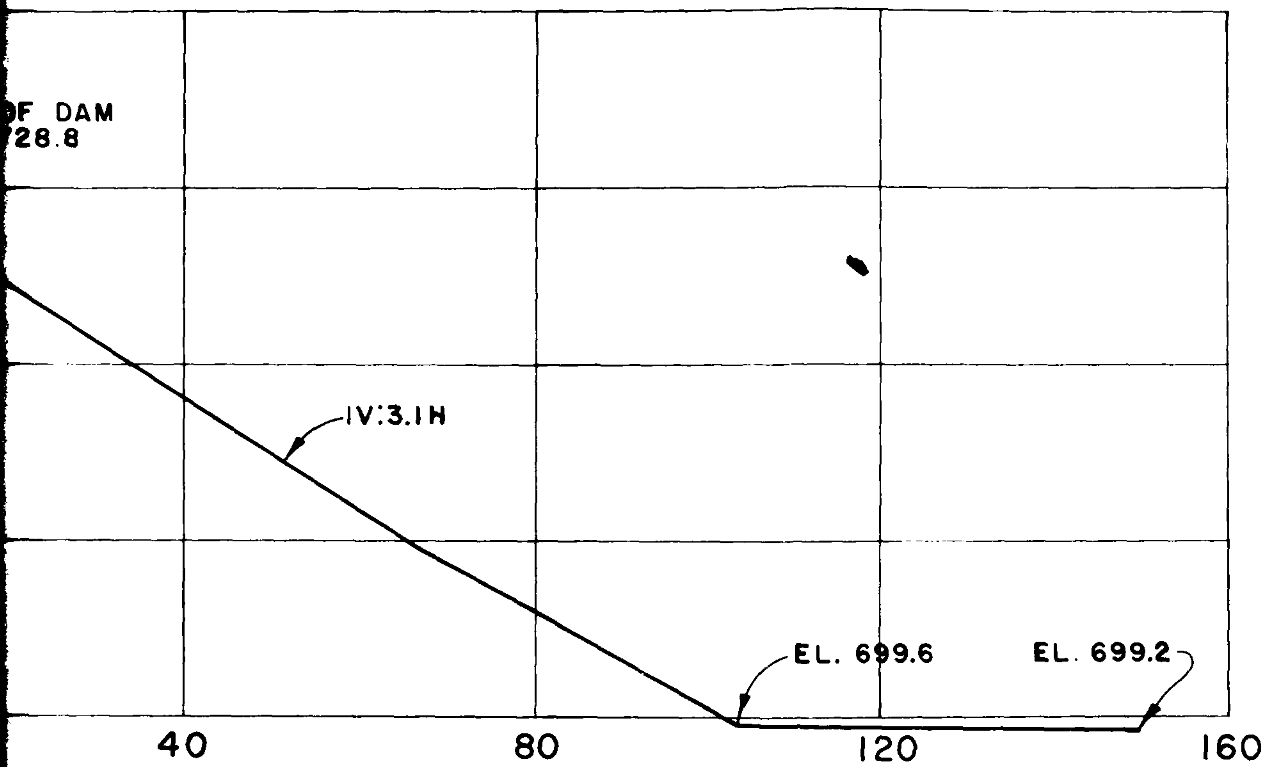

DAM CROSS-SECTION S

SCALES: 1"=10'V., 1"=2

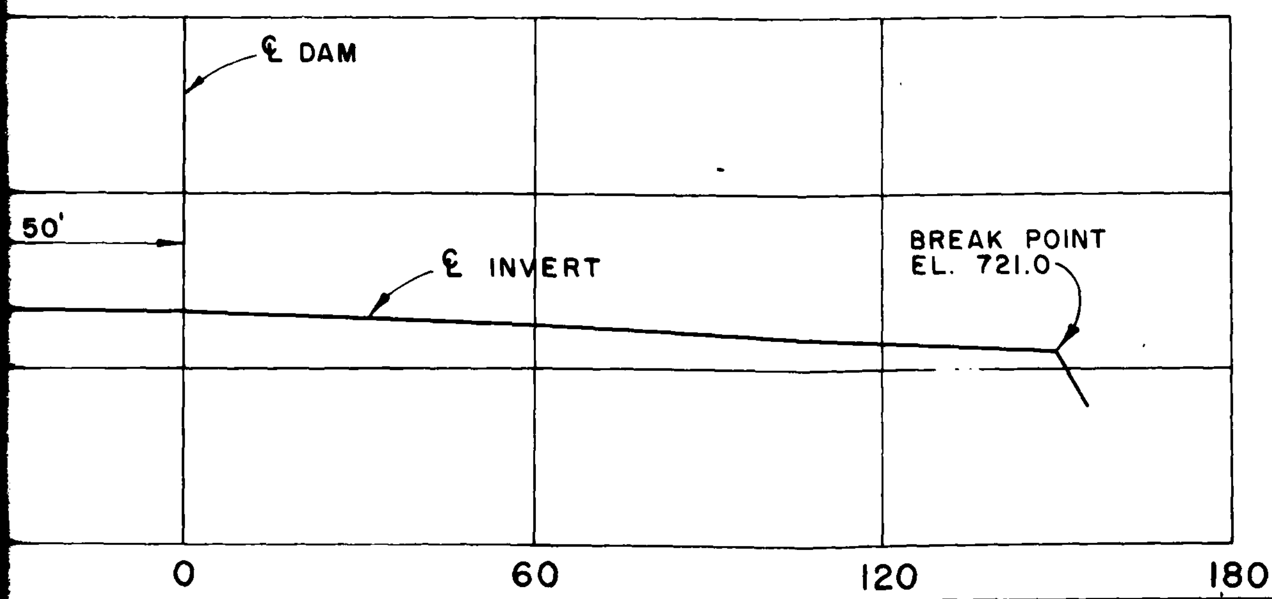



PROFILE SPILLWAY C

SCALES: 1"=10'V., 1"=3




ROSS-SECTION STA. 1+29
SCALES: 1"=10'V., 1"=20'H.



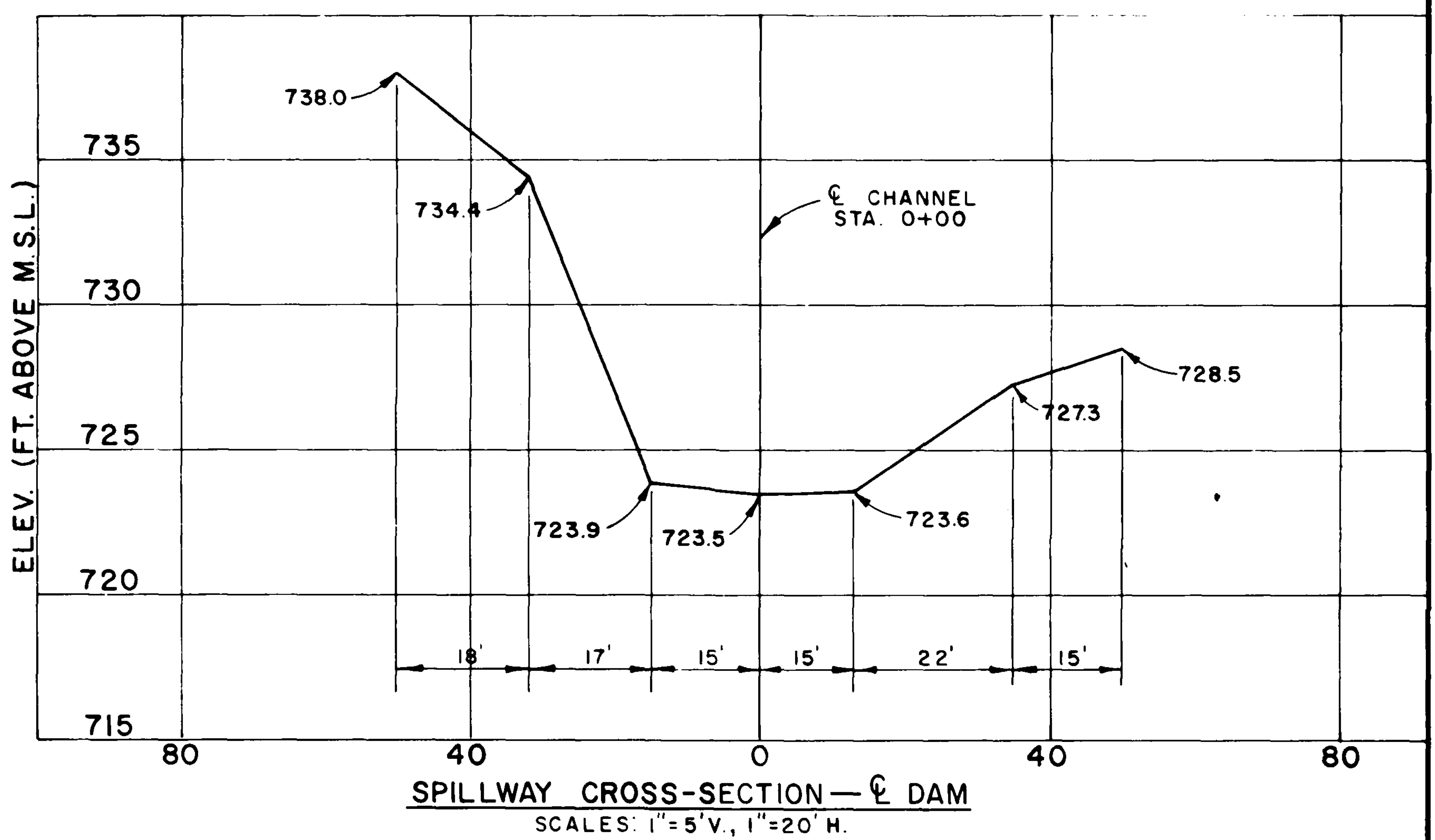

LE SPILLWAY CHANNEL
SCALES: 1"=10'V., 1"=30' H.

LAKE SCHEFFBORG
DAM CROSS-SECTION &
SPILLWAY PROFILE

Horner & Shifrin, Inc. August 1980

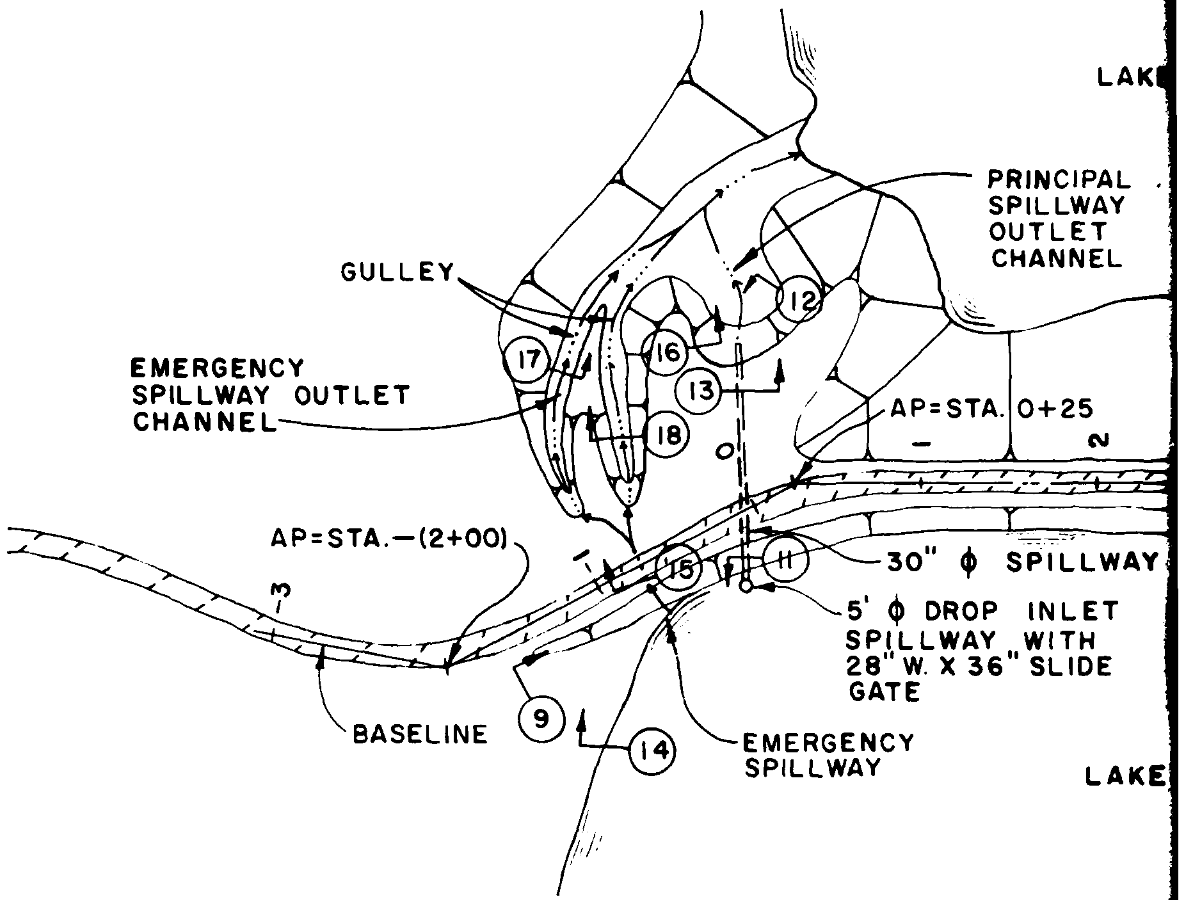
PLATE 5

12



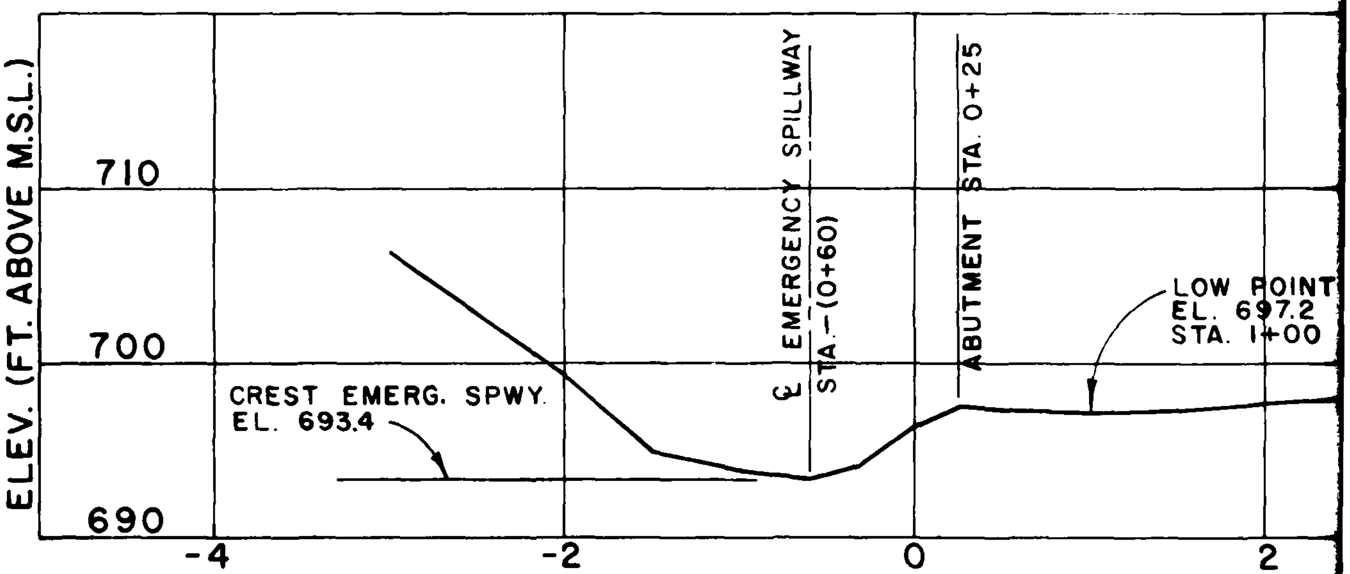

LAKE SCHEFFBORG
SPILLWAY CROSS-SECTION

Horner & Shifrin, Inc. August 1980




GENERAL PLAN OF

SCALE: 1"=100'

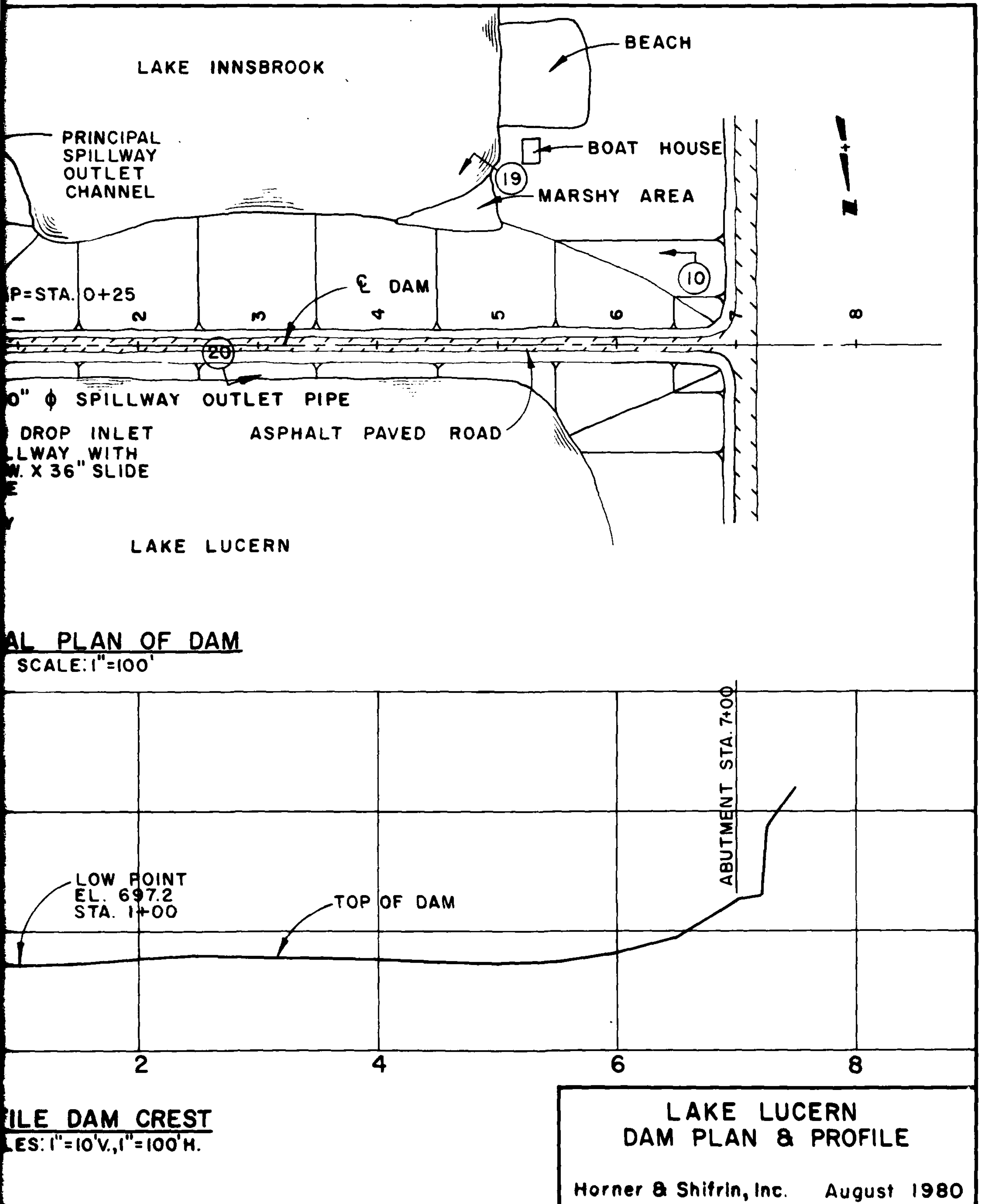



PROFILE DAM CRE

SCALES: 1"=10'V., 1"=100'

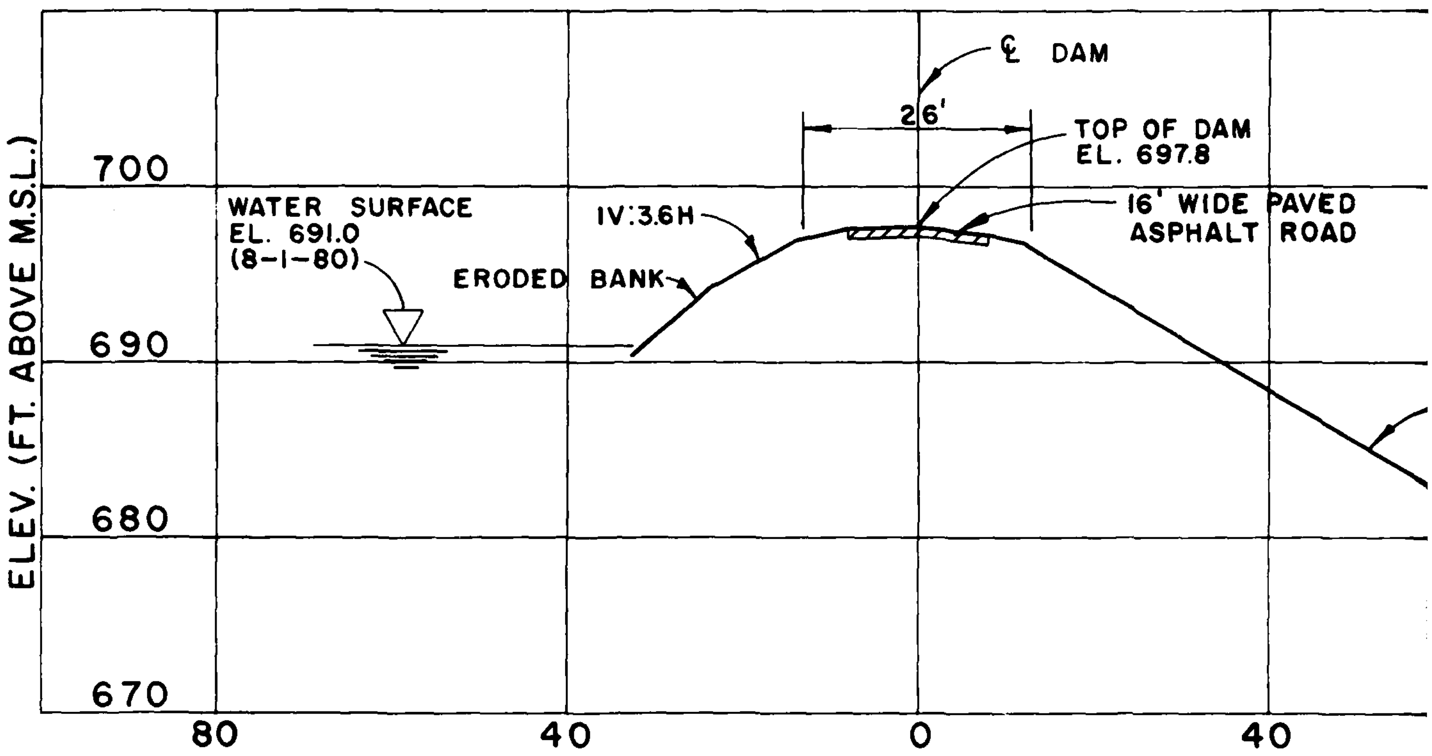
6

PHOTO LOCATION & KEY
(SEE APPENDIX A)


LAKE INNSBROOK
BEACH
PRINCIPAL SPILLWAY OUTLET CHANNEL
BOAT HOUSE
19
MARSHY AREA
10
P=STA. 0+25
℄ DAM
1 2 3 4 5 6 7 8
20
0" ϕ SPILLWAY OUTLET PIPE
DROP INLET
LLWAY WITH
W. X 36" SLIDE
ASPHALT PAVED ROAD
LAKE LUCERN
AL PLAN OF DAM
SCALE: 1"=100'
ABUTMENT STA. 7+00
LOW POINT
EL. 697.2
STA. 1+00
TOP OF DAM
2 4 6 8
ILE DAM CREST
LES: 1"=10'V., 1"=100'H.
LAKE LUCERN
DAM PLAN & PROFILE
Horner & Shifrin, Inc. August 1980

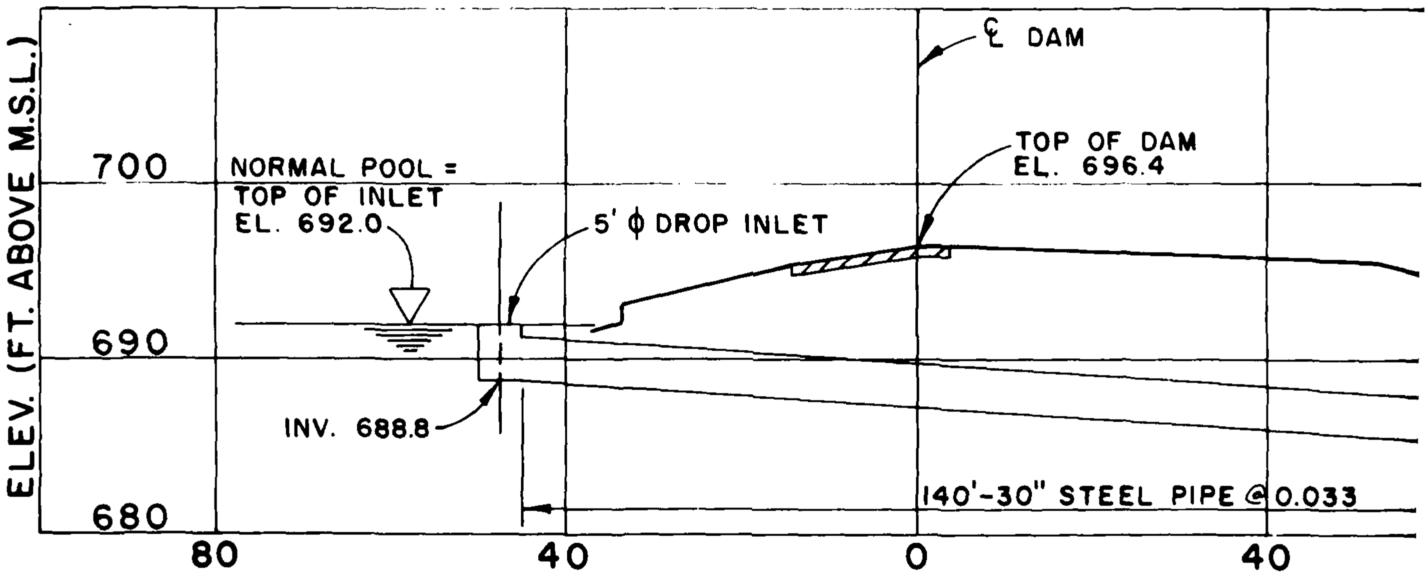
1 2

PLATE 7



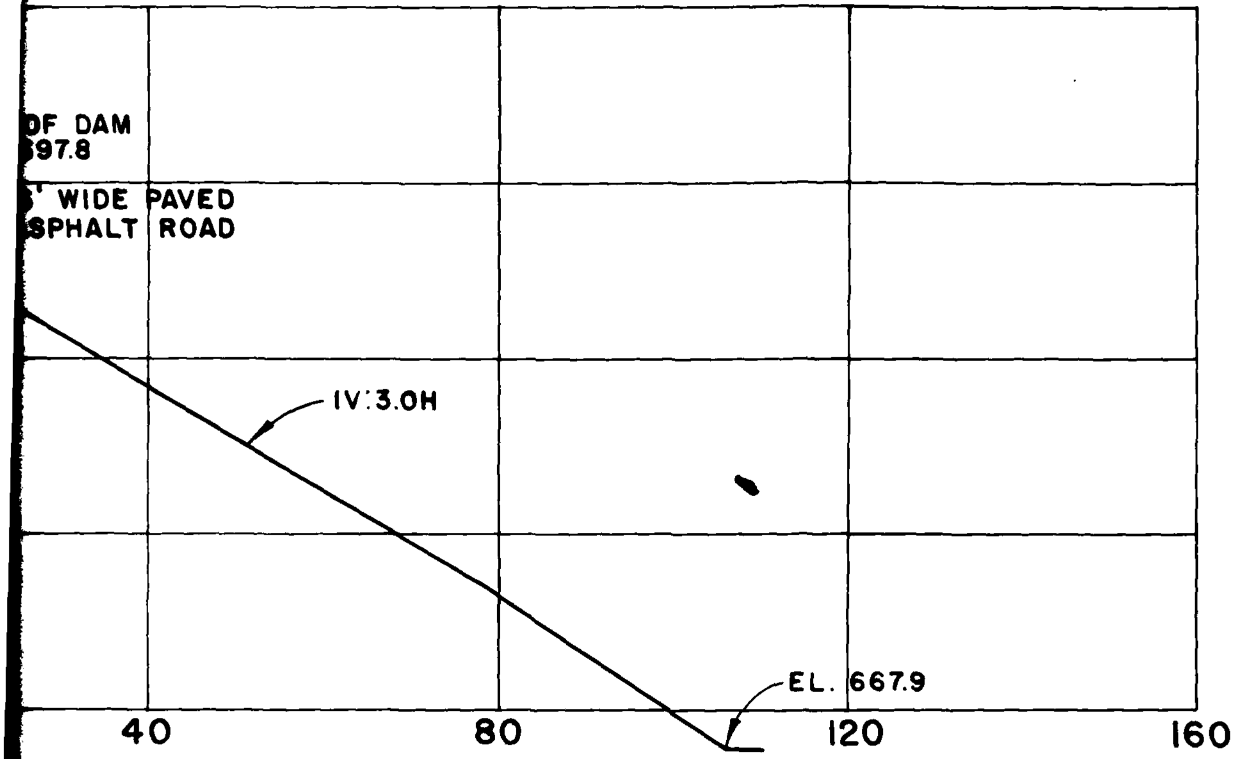

DAM CROSS-SECTION STA. 2

SCALES: 1"=10' V., 1"=20' H.

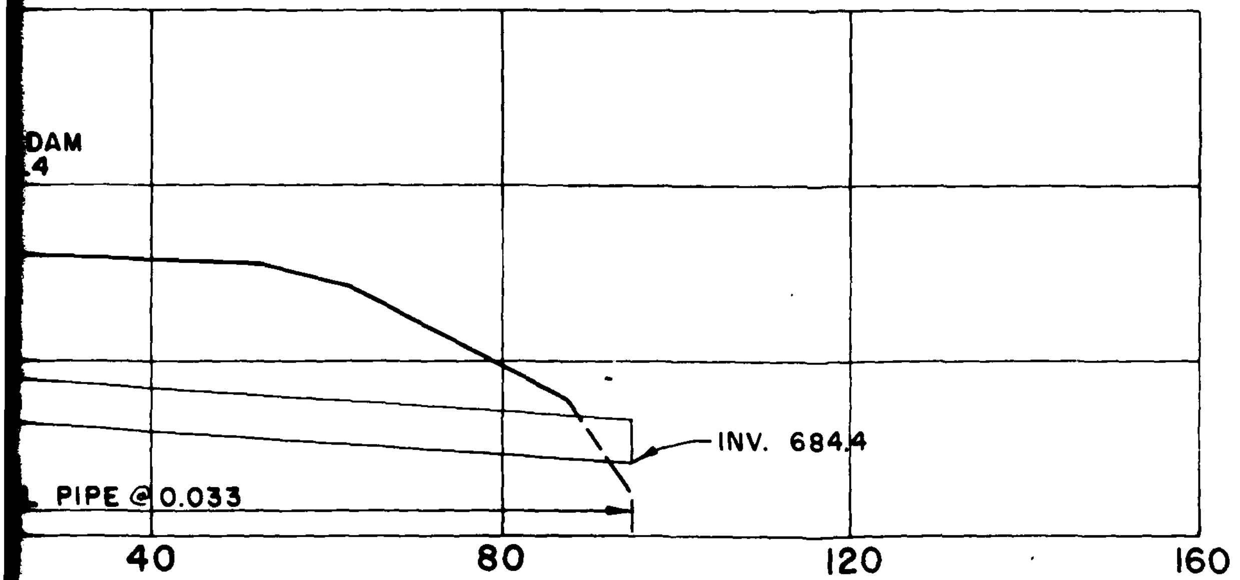



PROFILE PRINCIPAL SPILLW

SCALES: 1"=10' V., 1"=20' H.




ECTION STA. 2+50
: 1"=10' V., 1"=20' H.



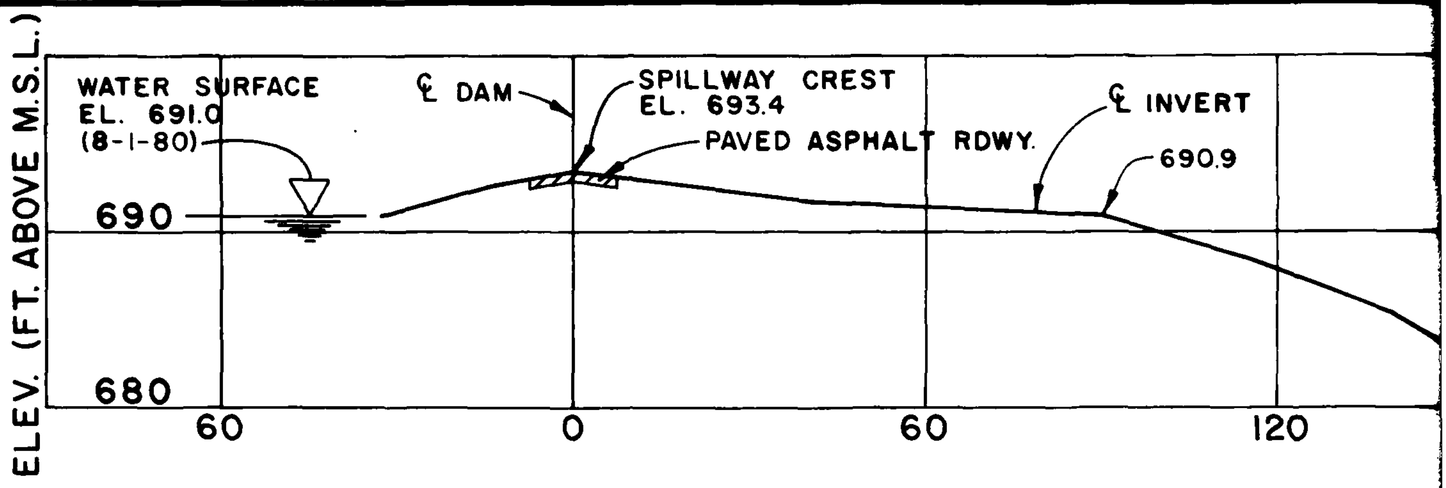

NCIPAL SPILLWAY
"=10' V., 1"=20' H.

LAKE LUCERN
DAM CROSS-SECTION &
SPILLWAY PROFILE

Horner & Shifrin, Inc. August 1980

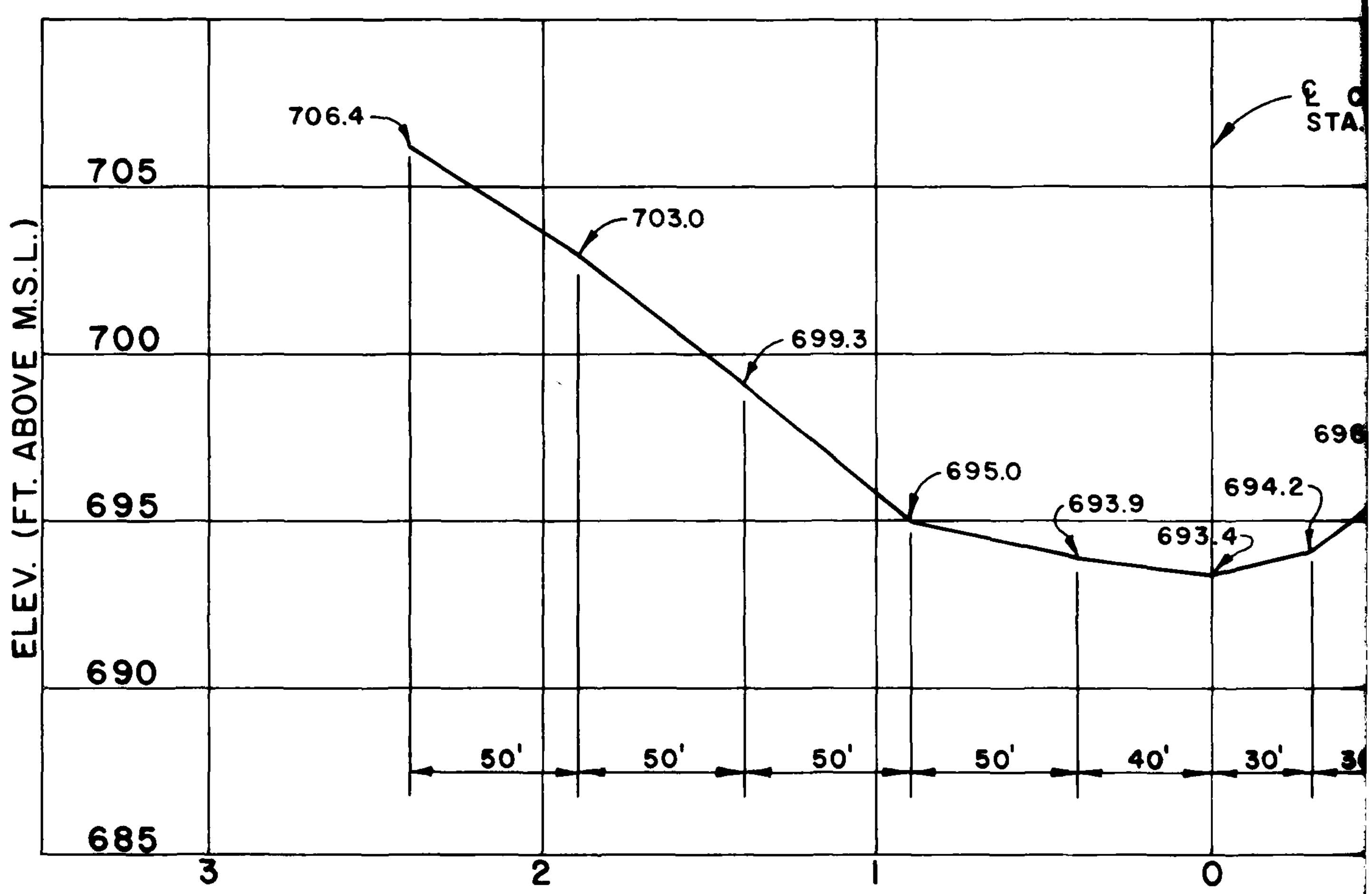
12

PLATE 8



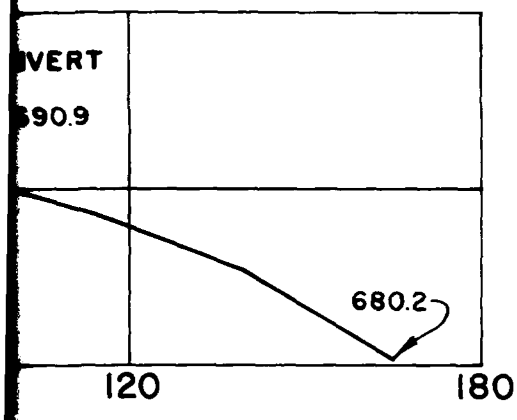

EMERGENCY SPILLWAY PROFILE

SCALES: 1"=10' V., 1"=30' H.

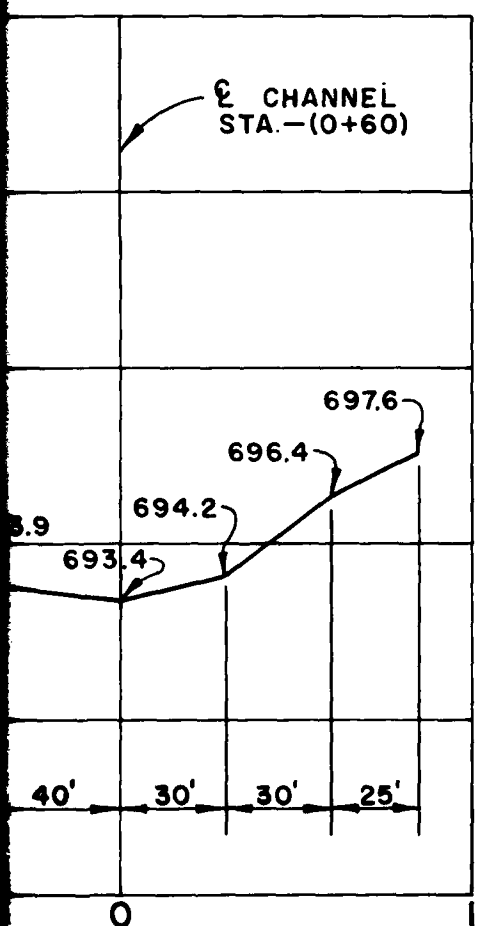



EMERGENCY SPILLWAY CROSS-SECTION — ℄ DAM

SCALES: 1"=5' V., 1"=50' H.




ILE

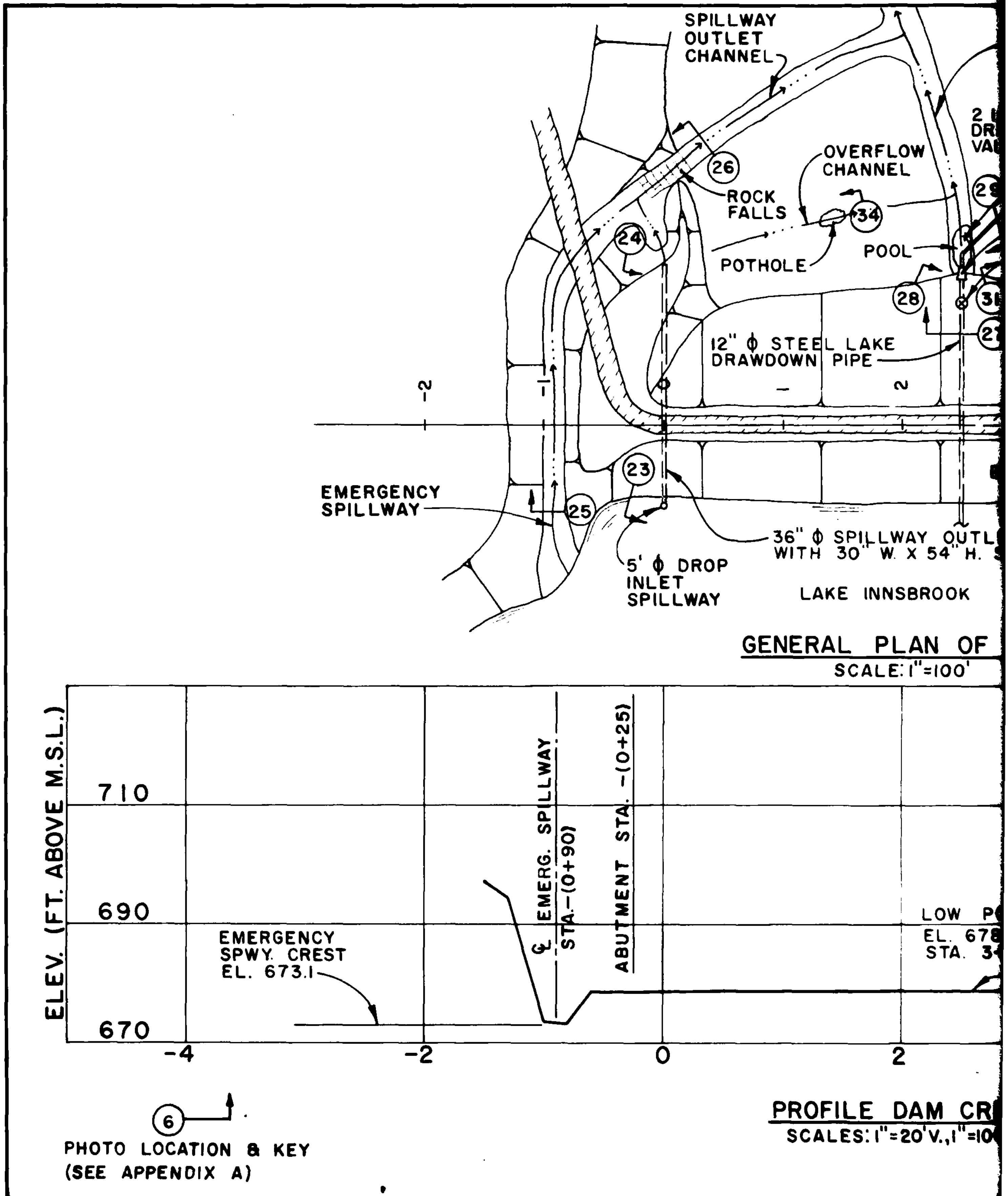



ON — ℄ DAM

LAKE LUCERN
EMERGENCY SPILLWAY PROFILE
& CROSS-SECTION
Horner & Shifrin, Inc. August 1980

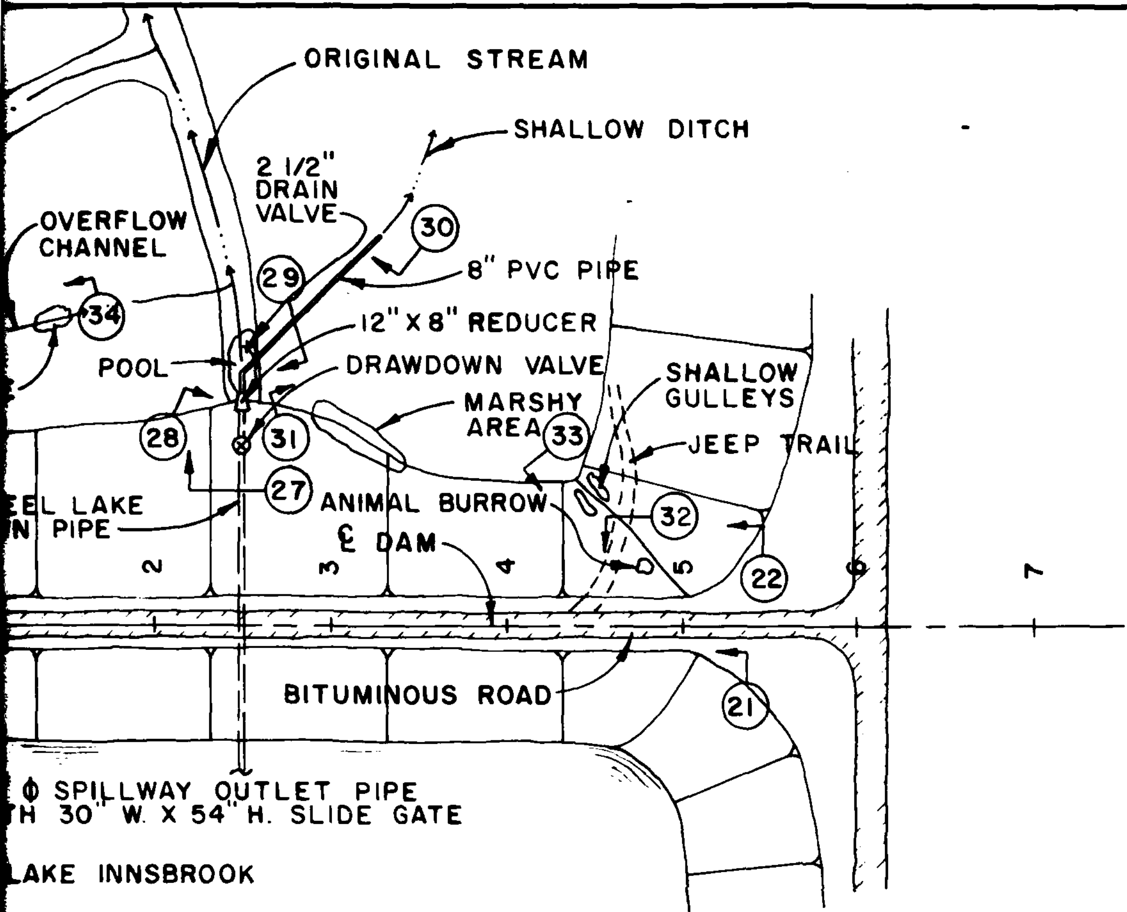
12

PLATE 9

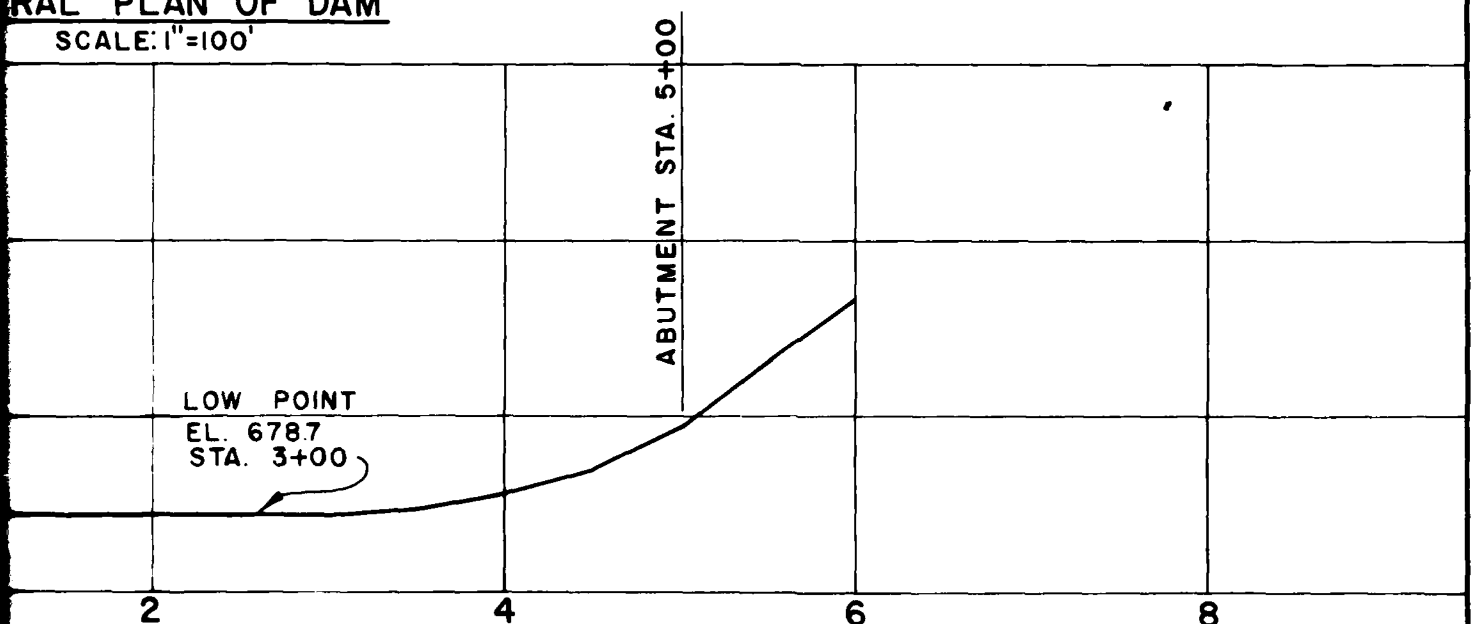



6

PHOTO LOCATION & KEY
(SEE APPENDIX A)




RAL PLAN OF DAM
SCALE: 1"=100'



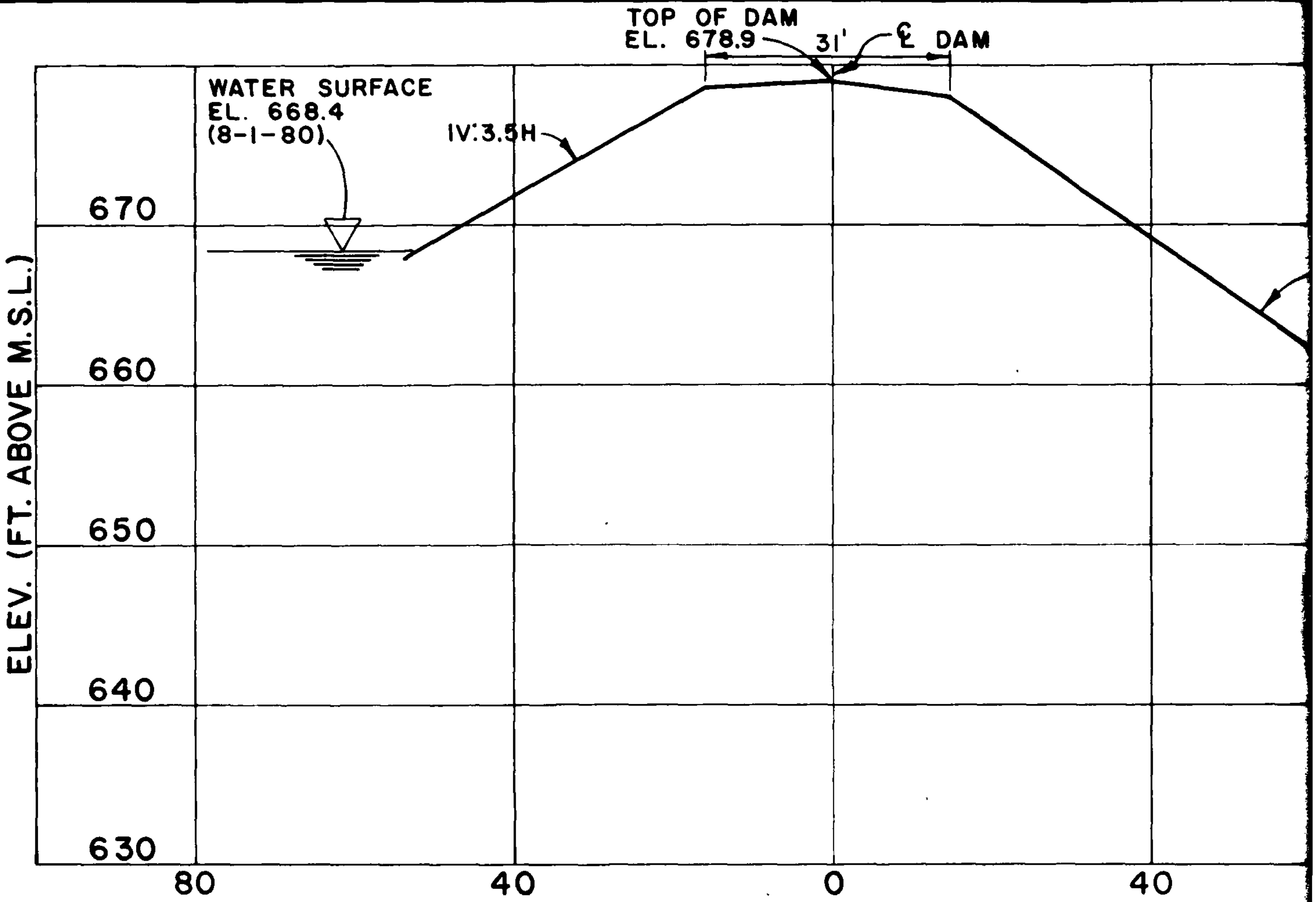

OFILE DAM CREST
ALES: 1"=20'V., 1"=100'H.

LAKE INNSBROOK
DAM PLAN & PROFILE

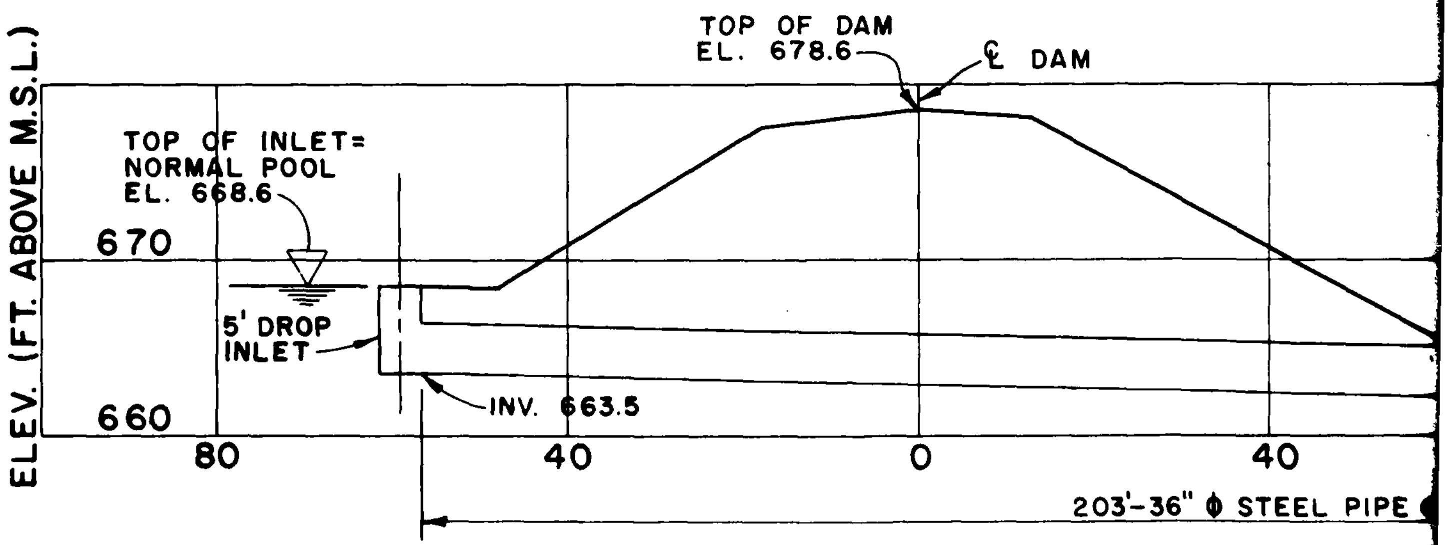
Horner & Shifrin, Inc. August 1980

12

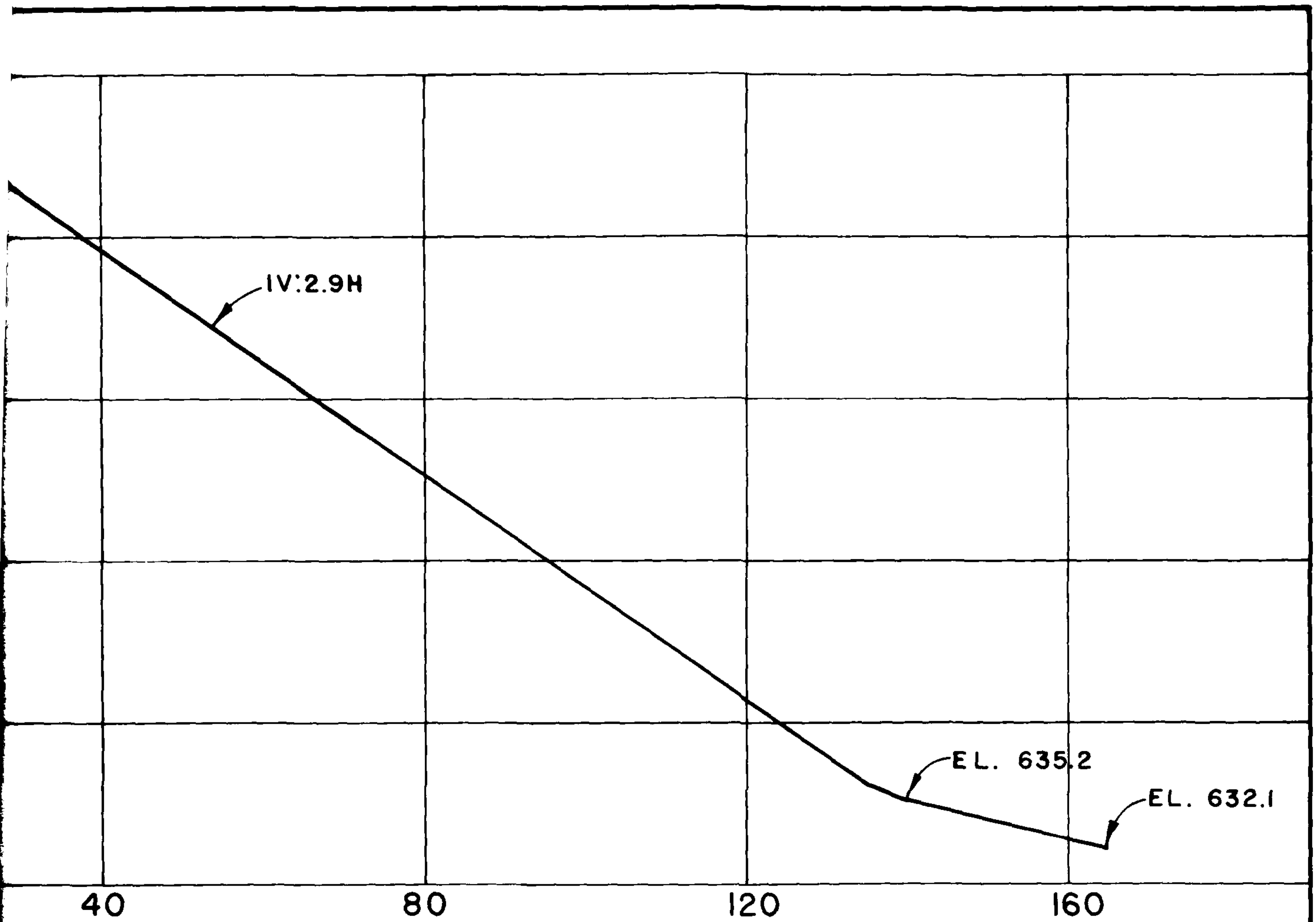
PLATE 10



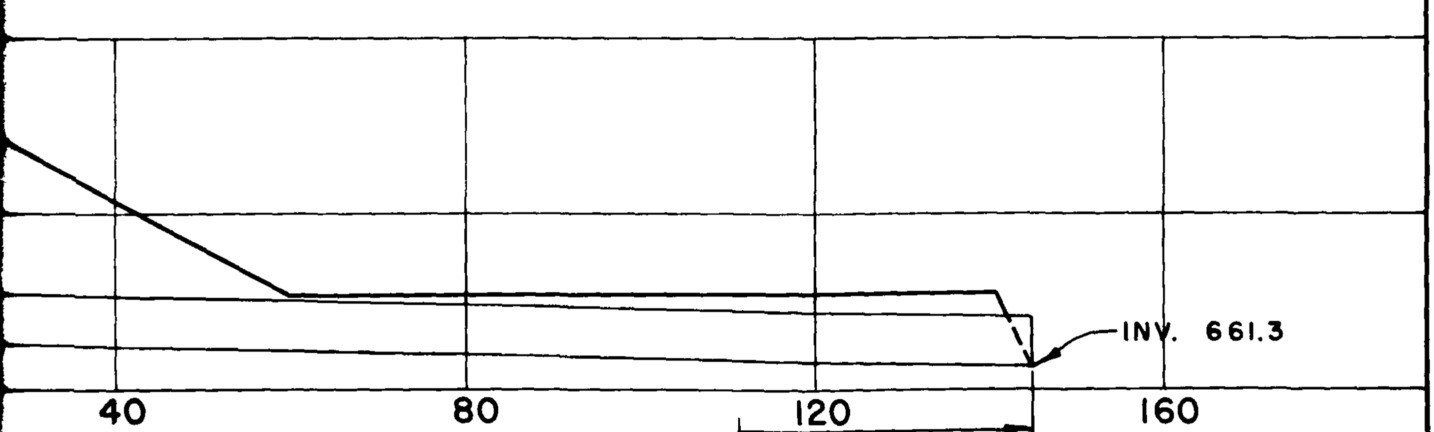

DAM CROSS-SECTION ST
SCALES: 1"=10'V., 1"=2




PROFILE PRINCIPAL SP
SCALES: 1"=10'V., 1"=20'




S-SECTION STA. 2+50
LES: 1"=10' V., 1"=20' H.




6" ϕ STEEL PIPE @ 0.0103

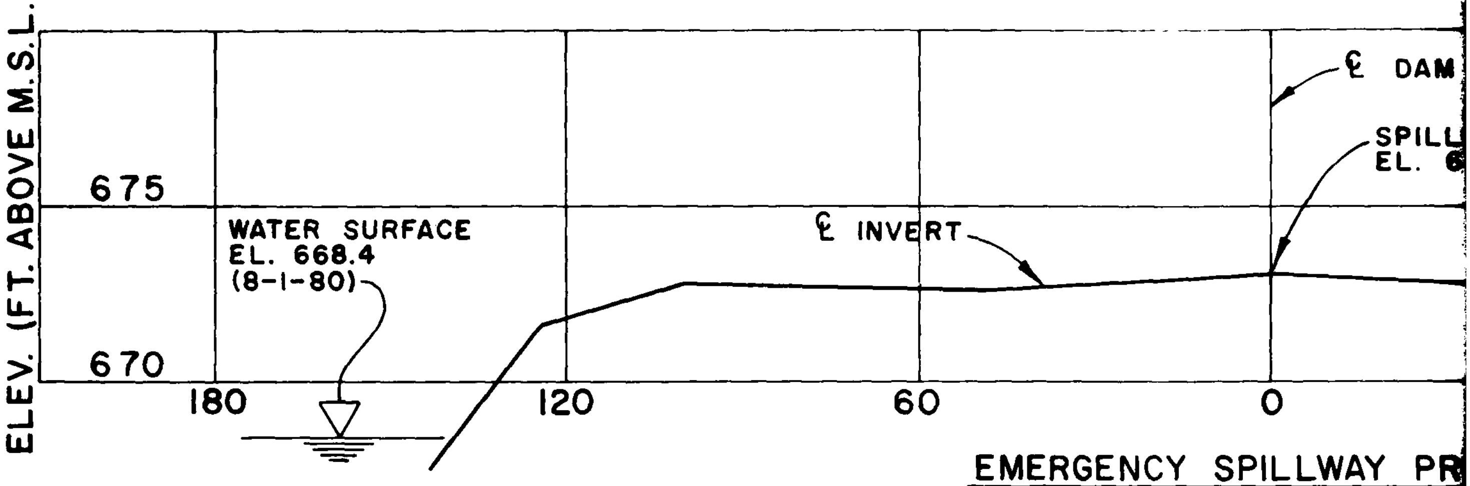
PRINCIPAL SPILLWAY
ES: 1"=10' V., 1"=20' H.

LAKE INNSBROOK
DAM CROSS-SECTION &
SPILLWAY PROFILE

Horner & Shifrin, Inc. August 1980

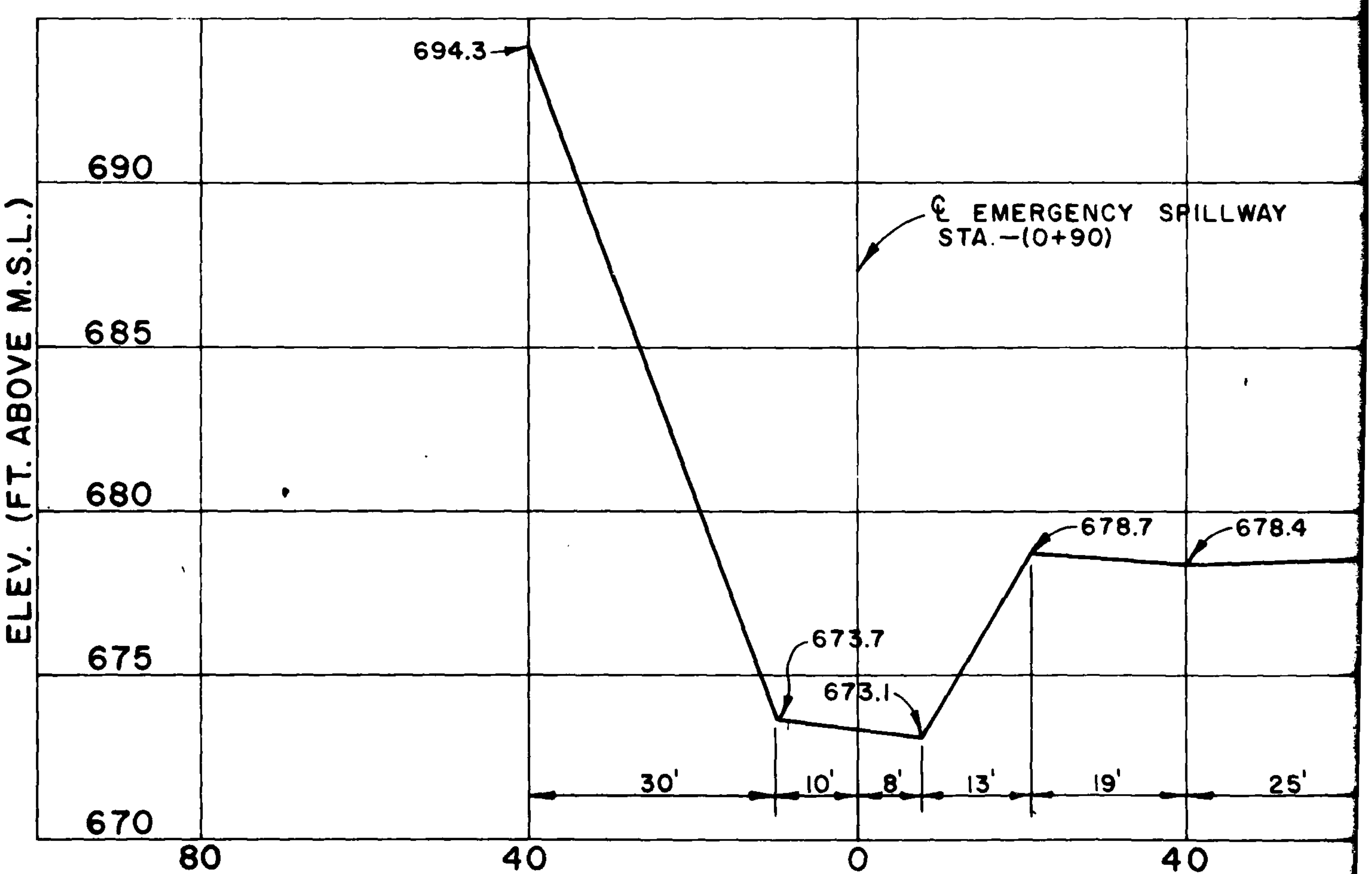
PLATE 11

12



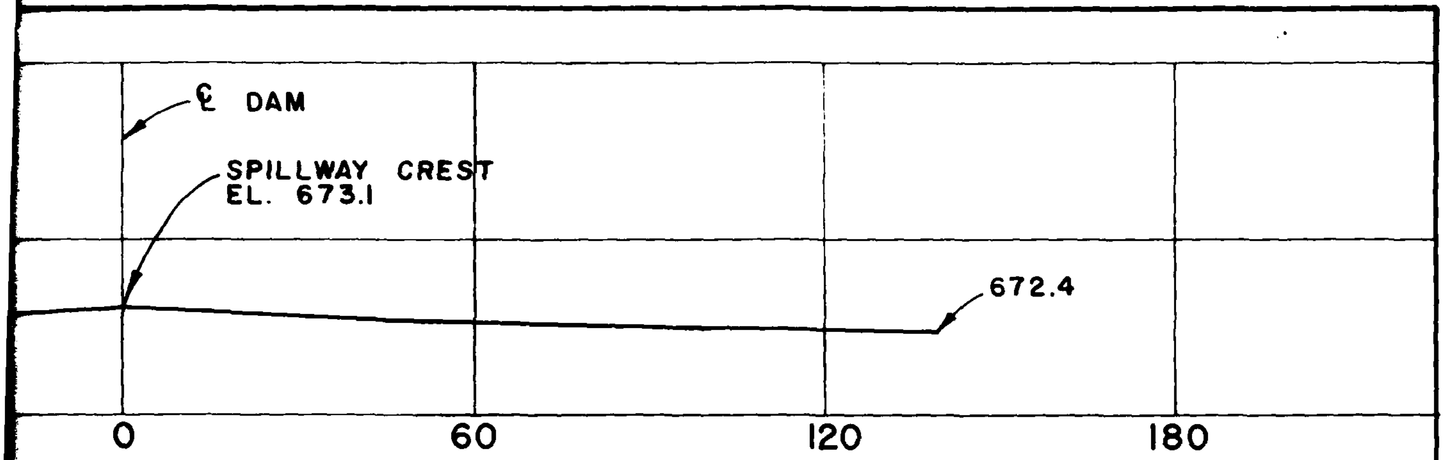

EMERGENCY SPILLWAY PR

SCALES: 1"=5'V., 1"=30' H.



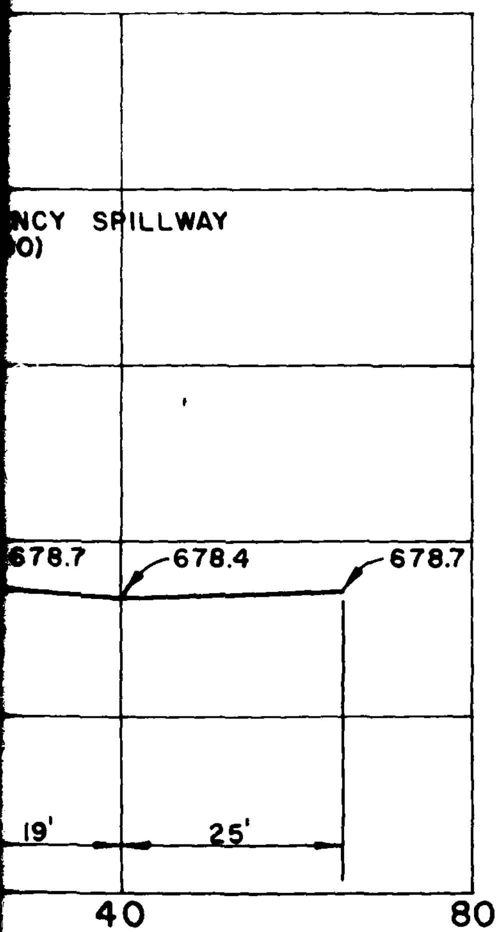

EMERGENCY SPILLWAY CROSS-SECTION—℄ DAM

SCALES: 1"=5'V., 1"=20' H.




Y SPILLWAY PROFILE

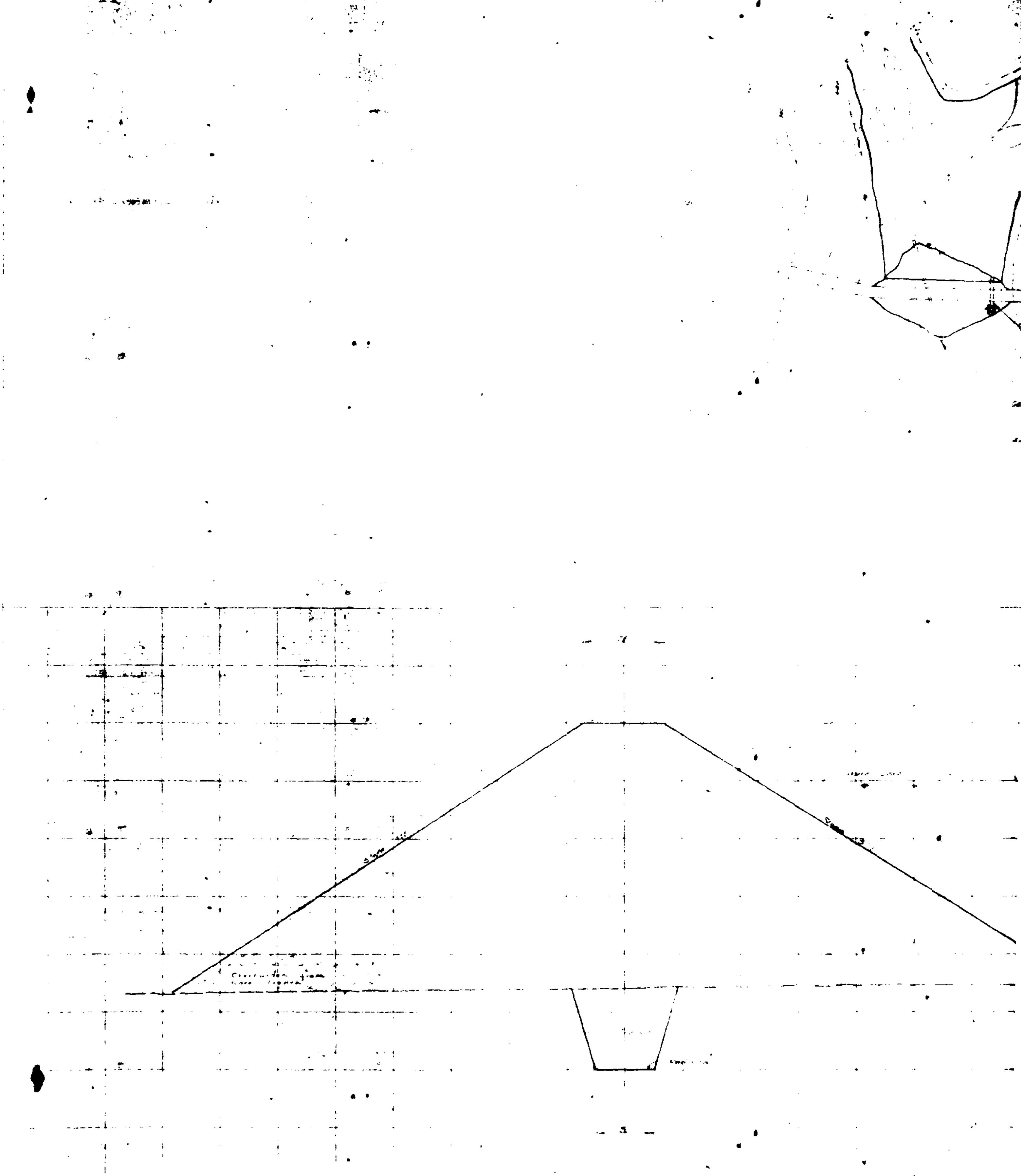
ES: 1" = 5' V., 1" = 30' H.




ON–℄ DAM

LAKE INNSBROOK
EMERGENCY SPILLWAY PROFILE
& CROSS-SECTION

Horner & Shifrin, Inc. August 1980



PLAN AND PROFILE

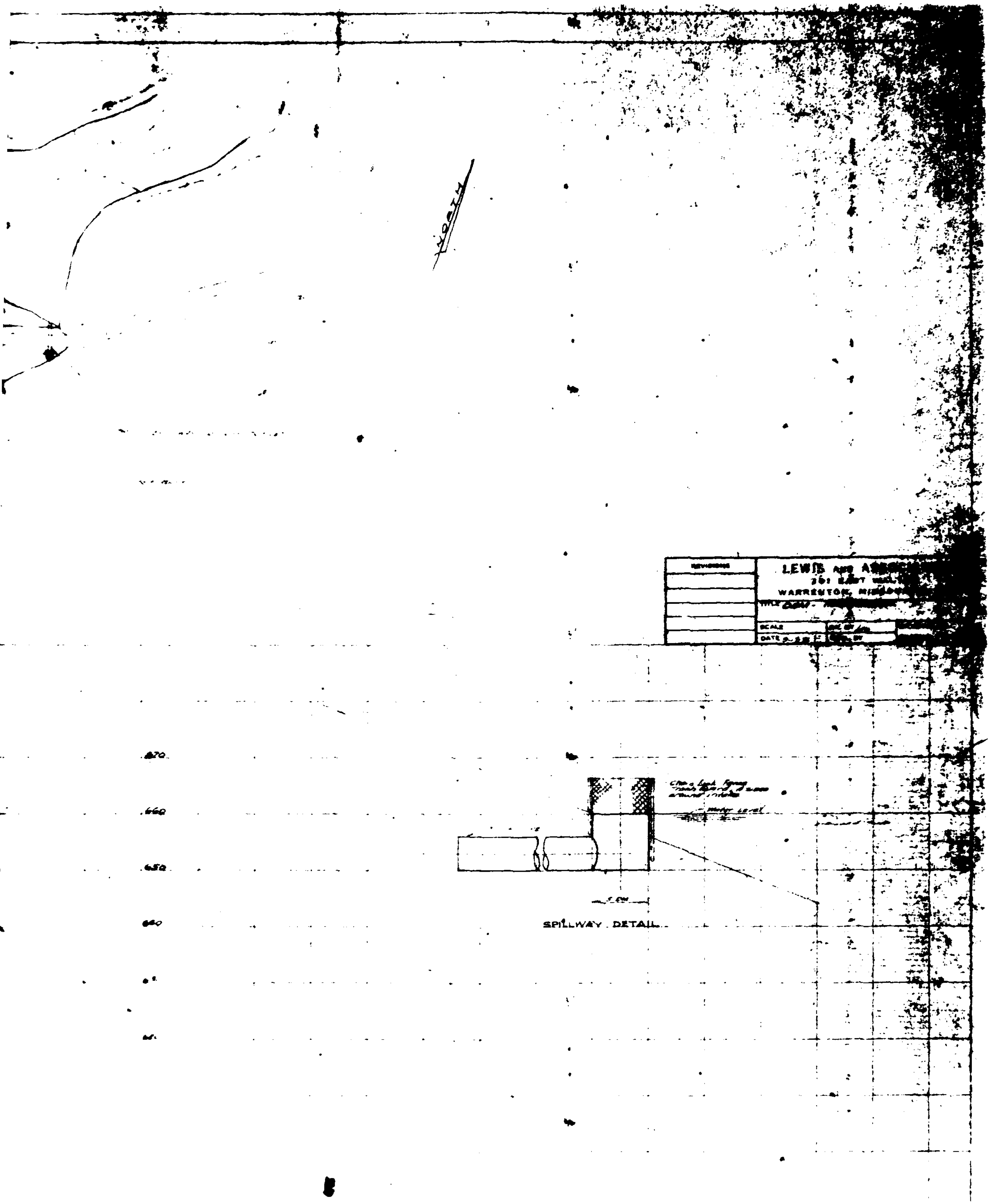
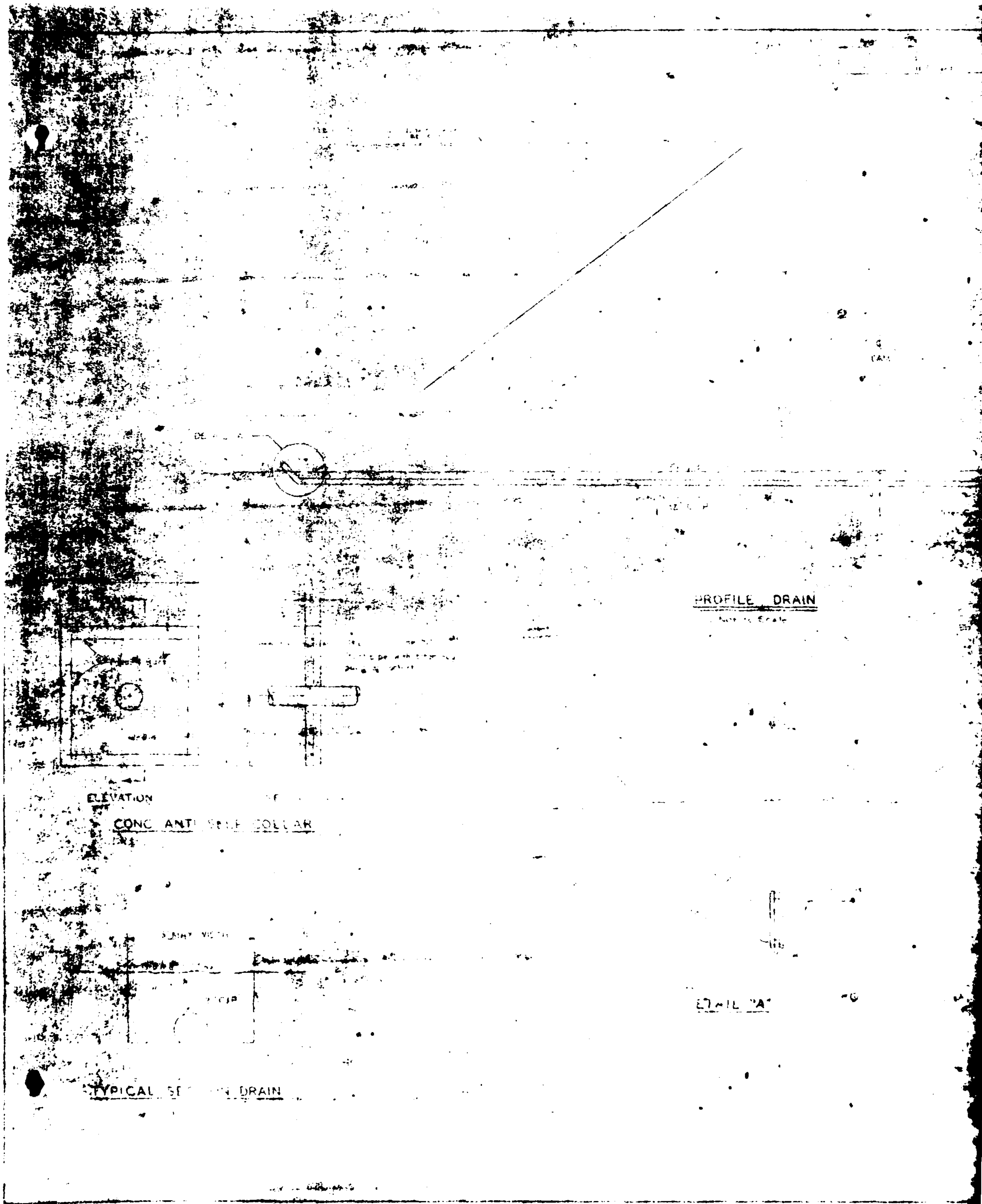

NORTH
REVISIONS
LEWIS
WARRENTON,
SCALE
DATE
670
660
650
640
Water Level
SPILLWAY DETAIL

PLATE 13


PROFILE DRAIN
ELEVATION
CONC
COLLAR
DRAIN

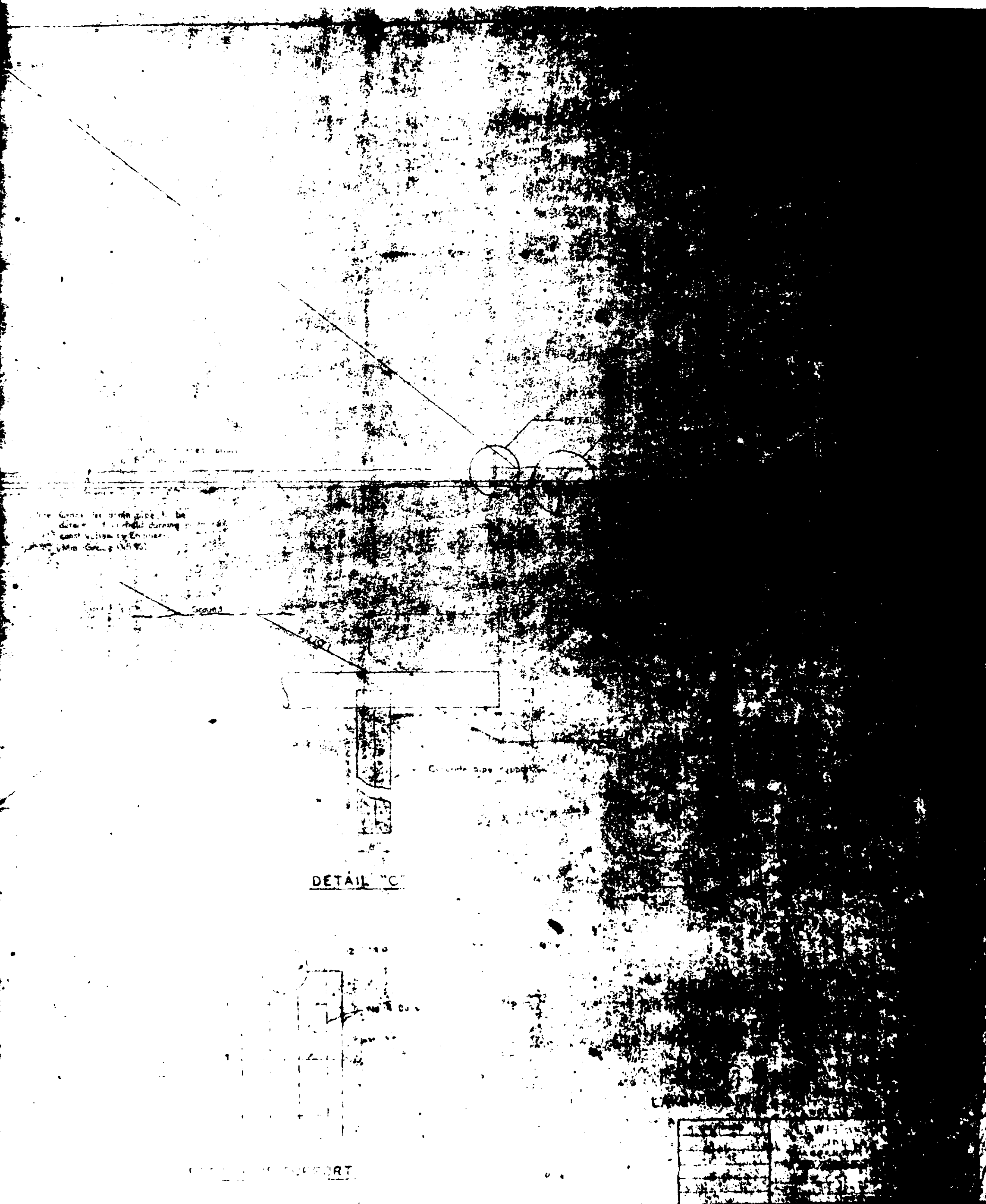



PLATE 14

.12

# APPENDIX A

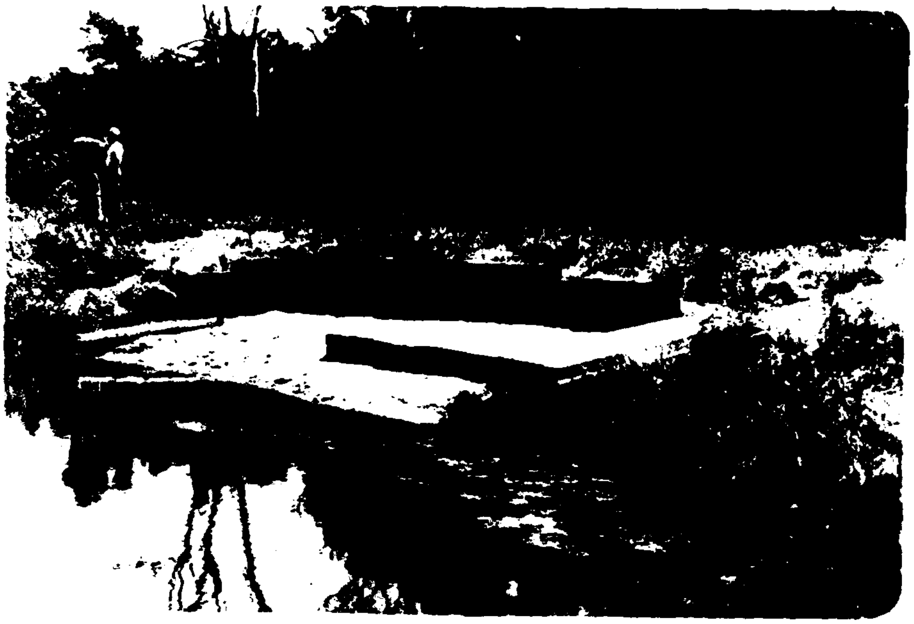
## INSPECTION PHOTOGRAPHS

INSPECTION PHOTOGRAPHS - LAKE SCHEFFBORG DAM

NO. 1: UPSTREAM FACE OF DAM

NO. 2: DOWNSTREAM FACE OF DAM

INSPECTION PHOTOGRAPHS - LAKE [illegible] DAM



NO. 3: BEACH AREA NEAR RIGHT ABUTMENT

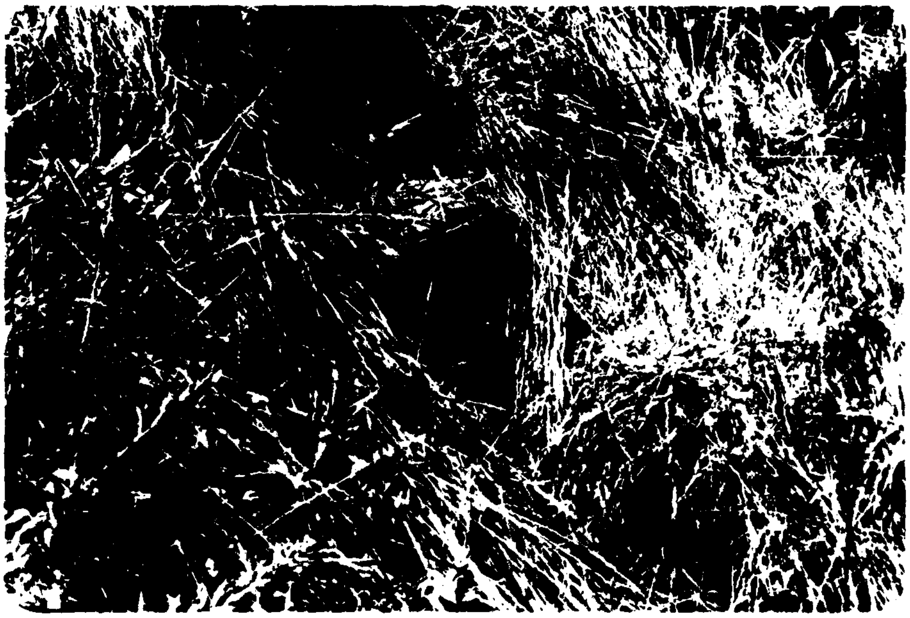
NO. 4: SPILLWAY CHANNEL - LOOKING DOWNSTREAM FROM CREST

INSPECTION PHOTOGRAPHS - LAKE SCHEFFBORG DAM

NO. 5: POTHOLE IN SPILLWAY OUTLET CHANNEL

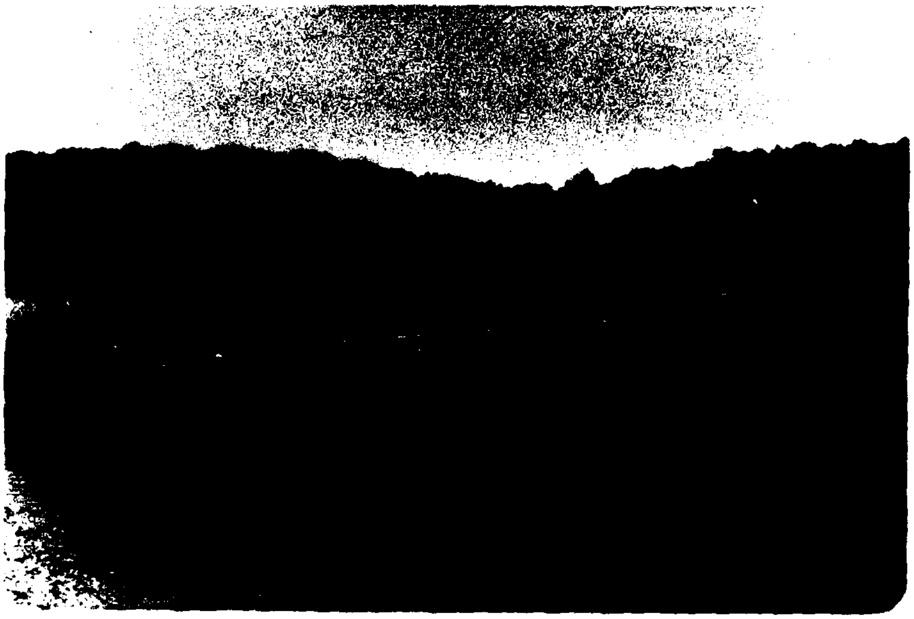
NO. 6: FALLEN TREES ACROSS SPILLWAY OUTLET CHANNEL

NO. 7: LAKE DRAWDOWN PIPE VALVE ENCLOSURE

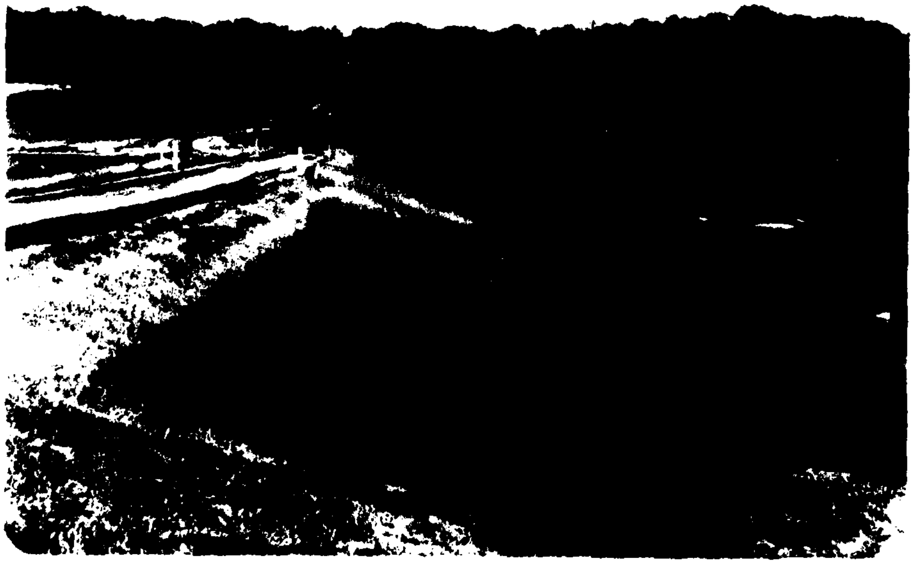


NO. 8: DOWNSTREAM END OF 15" LAKE DRAWDOWN PIPE

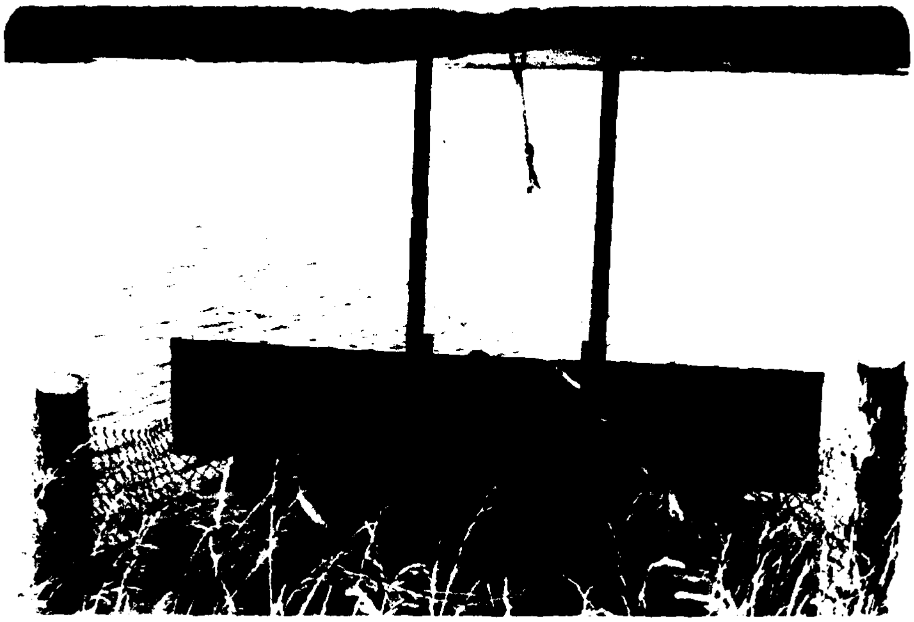
INSPECTION PHOTOGRAPHS - LAKE [illegible] DAM



NO. 9: UPSTREAM FACE OF DAM



NO. 10: CREST AND DOWNSTREAM FACE OF DAM



NO. 11: DROP INLET SPILLWAY

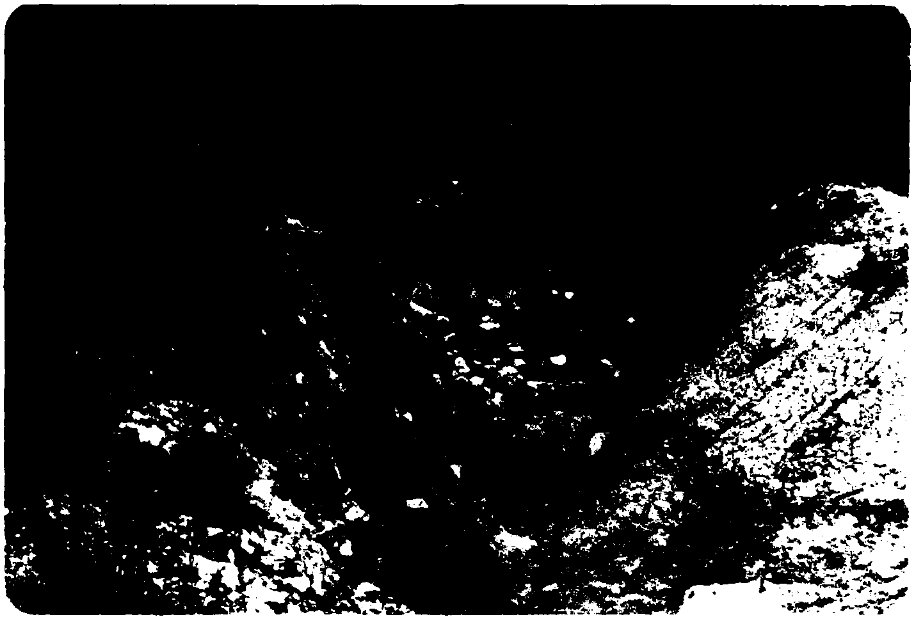
NO. 12: DOWNSTREAM END OF 30" SPILLWAY OUTLET PIPE

NO. 13: SPILLWAY OUTLET CHANNEL - LOOKING DOWNSTREAM FROM 30" PIPE

NO. 14: CREST OF EMERGENCY SPILLWAY

NO. 15: UPSTREAM END OF EMERGENCY SPILLWAY OUTLET CHANNEL

NO. 16: JUNCTION OF SPILLWAY OUTLET CHANNELS



NO. 17: LEFT SIDE OF EMERGENCY SPILLWAY OUTLET CHANNEL - LOOKING DOWNSTREAM

NO. 18: RIGHT SIDE OF EMERGENCY SPILLWAY OUTLET CHANNEL - LOOKING DOWNSTREAM

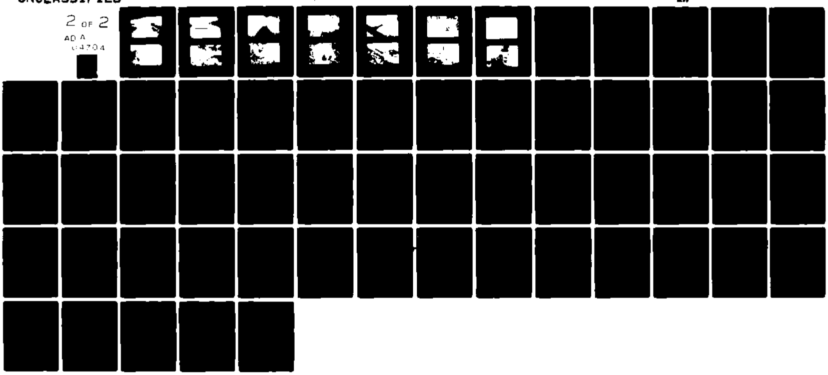
NO. 19: MARSHY AREA AT TOE OF DAM

NO. 20: EMBANKMENT EROSION AT UPSTREAM FACE OF DAM

AD-A104 704 HORNER AND SHIFRIN INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE SCHEFFBORG DAM (MO 31442), LA--ETC(U)
OCT 80 DACW43-80-C-0063

UNCLASSIFIED

2 OF 2
AD A
104704



NO. 21: CREST AND UPSTREAM FACE OF DAM

NO. 22: DOWNSTREAM FACE OF DAM

NO. 23: DROP INLET SPILLWAY

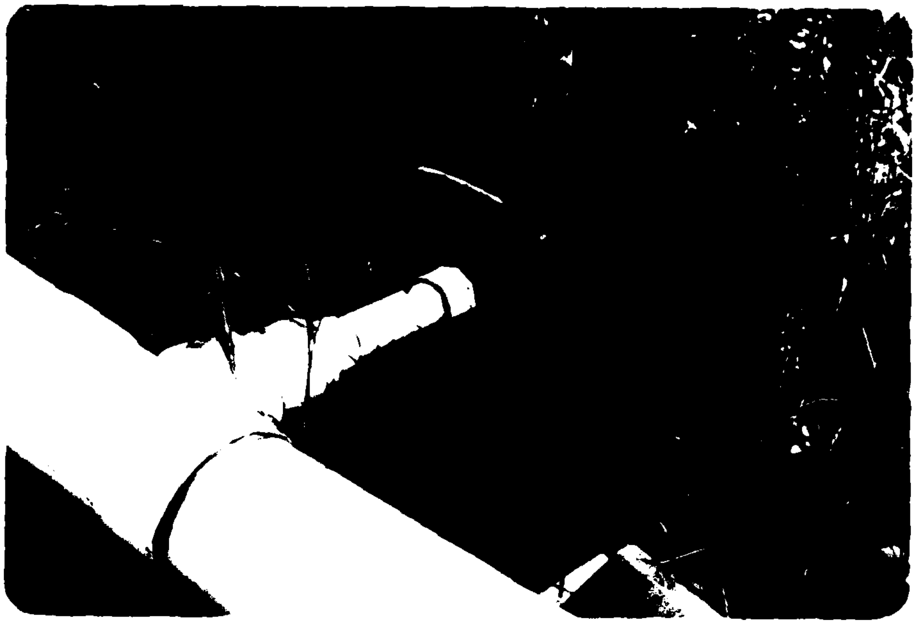
NO. 24: DOWNSTREAM END OF 36" DIAMETER SPILLWAY OUTLET PIPE

NO. 25: EMERGENCY SPILLWAY CHANNEL - LOOKING DOWNSTREAM FROM CREST

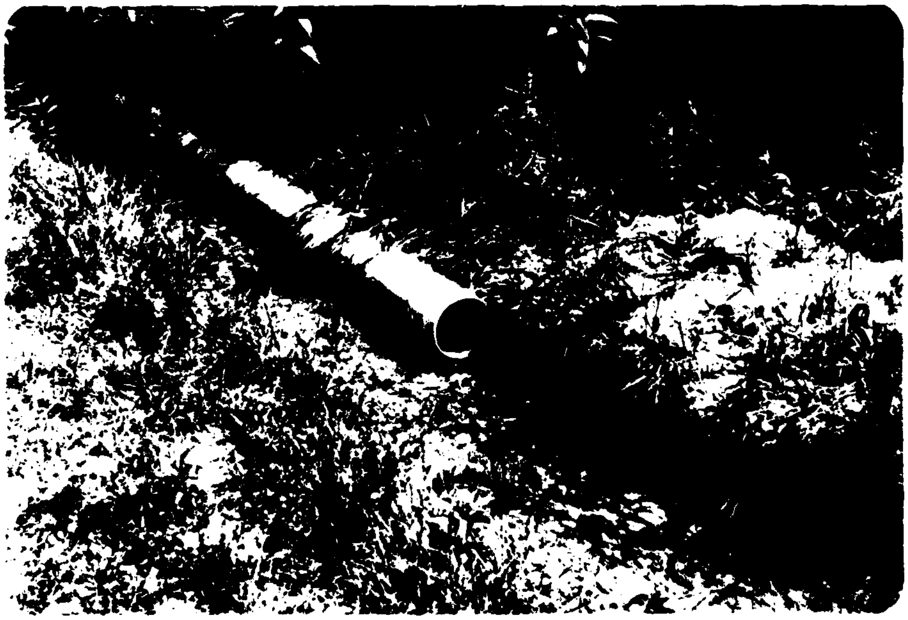
NO. 26: ROCK FALLS AT EXIT SECTION OF SPILLWAY OUTLET CHANNEL

NO. 27: LAKE DRAWDOWN DISCHARGE PIPING AT TOE OF DAM

NO. 28: VALVE FOR LAKE DRAWDOWN PIPE



NO. 29: DRAIN VALVE FOR LAKE DRAWDOWN PIPING



NO. 30: DOWNSTREAM END OF LAKE DRAWDOWN PIPE

NO. 31: SEEPAGE AT TOE OF DAM

NO. 32: ANIMAL BURROW IN DOWNSTREAM FACE OF DAM

INSPECTION PHOTOGRAPHS - LAKE INNSBROOK DAM

NO. 33: EROSION GULLEYS IN DOWNSTREAM FACE OF DAM AT RIGHT ABUTMENT

NO. 34: POTHOLE IN SPILLWAY OVERFLOW CHANNEL

# APPENDIX B

## HYDROLOGIC AND HYDRAULIC ANALYSES

## HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 25.0 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent probability flood was provided by the St. Louis District, Corps of Engineers.

b. Drainage areas:

| Subarea | | Square miles | Acres |
|---|---|---|---|
| Lake A | | 0.268 | 172 |
| Lake 30512 | | 0.075 | 48 |
| Lake Scheffborg | | 0.545 | 349 |
| Lake B | | 0.086 | 55 |
| Lake Lucern | | 1.275 | 816 |
| Lake 30520 | | 0.055 | 35 |
| Lake C | | 0.045 | 28 |
| Lake 31443 | | 0.079 | 51 |
| Lake Innsbrook | | 1.432 | 916 |
| | Total | 3.860 | 2,470 |

c. SCS parameters:

| Lake | Length L (miles) | Elev. Difference H (feet) | Travel Time $T_c$ (hours) | Lag Time L (hours) |
|---|---|---|---|---|
| A | 0.701 | 80 | 0.319 | 0.191 |
| 30512 | 0.284 | 52 | 0.132 | 0.079 |
| Scheffborg | 0.814 | 116 | 0.328 | 0.197 |
| B | 0.189 | 34 | 0.097 | 0.058 |
| Lucern | 2.064 | 130 | 0.918 | 0.551 |
| 30520 | 0.227 | 51 | 0.103 | 0.062 |
| C | 0.208 | 44 | 0.099 | 0.059 |
| 31443 | 0.227 | 68 | 0.092 | 0.055 |
| Innsbrook | 1.856 | 154 | 0.764 | 0.458 |

*Time of Concentration ($T_c$) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$

Lag Time = 0.6 $T_c$

| Lake | % Hydrologic Soil Group B | C | D | CN (AMC II) | CN (AMC III) |
|---|---|---|---|---|---|
| A | -- | 11 | 89 | 83 | 93 |
| 30512 | -- | 36 | 64 | 80 | 91 |
| Scheffborg | 9 | 36 | 55 | 78 | 90 |
| B | -- | 14 | 86 | 84 | 93 |
| Lucern | 2 | 50 | 48 | 79 | 91 |
| 30520 | -- | 36 | 64 | 84 | 93 |
| C | -- | 40 | 60 | 80 | 91 |
| 31443 | -- | 95 | 5 | 78 | 90 |
| Innsbrook | 3 | 48 | 49 | 78 | 90 |

Hydrologic soil group data obtained from SCS County Soil Report.

2. Lake Scheffborg Dam. The spillway section for the Lake Scheffborg Dam consists of a broad-crested trapezoidal section excavated to a layer of natural rock.

Spillway release rates were determined as follows:

a. Spillway crest section properties (area, "a" and top width, "t") were computed for various depths, "d".

b. It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth was computed as $Qc = \left(\frac{a^3 g}{t}\right)^{0.5}$ for the various depths, "d". Corresponding

* The time of concentration ($T_c$) was obtained using method C as decribed in Figure 30, "Design of Small Dams" by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

velocities ($v_c$) and velocity heads ($H_{vc}$) were determined using conventional formulas.* Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, page 8-7.

c. Static lake levels corresponding to the various values passing the spillway were computed as critical depths plus critical velocity head ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

d. Spillway discharges for corresponding lake levels were entered on the Y4 and Y5 cards.

3. Lake Lucern Dam.

a. The principal spillway for the Lake Lucern Dam consists of a 60-inch diameter drop inlet with a 30-inch diameter steel outlet pipe.

Spillway releases for the drop inlet were computed utilizing equations and nomographs presented in "Design of Small Dams" by the U.S. Department of the Interior (USDI) for drop inlet type spillways. The rise of the nappe above the elevation of the crest lip was considered negligible. The following equation was used for crest control:

$$Q = C_o \ (2 \pi \ R_s) \ H_o^{3/2}$$

where "$C_o$" is a coefficient obtained from Figure 283 of the reference, expressed in terms of $H_o/R_s$, "$R_s$" is the radius, 2.5 feet, of the spillway crest, and "$H_o$" is the depth of flow over the crest.

When the ratio $H_o/R_s$ reached a value of 1.00, inflow was determined by assuming flow was over a sharp edge submerged

* $v_c = \frac{Qc}{a}$ ; $Hvc = \frac{v_c^2}{2g}$

orifice. The following equation was used: $Q = Ca\ (2gh)^{0.5}$, where "C" is a coefficient assumed to be 0.6, "a" is the area of the orifice, 19.63 sf, "h" is the height of flow above the orifice, and "g" is acceleration due to gravity. Reference, "Handbook of Hydraulics," Fifth Edition, by King and Brater, page 4-3.

Flow through the 30-inch diameter outlet pipe was determined using Bernoulli's equation for pressure flow in pipes. Losses, including throat, entrance, pipe and exit losses totaled 3.22 velocity heads. Reference, "Handbook of Hydraulics," Fifth Edition, by King and Brater, pages 8-5 and 8-6.

Discharge quantities, determined by the methods described herein were plotted versus corresponding lake water surface elevations to determine the discharge rating curve for the drop inlet spillway.

b. The emergency spillway for the Lake Lucern Dam consists of a broad-crested dish-shaped excavated earth section. Spillway releases and corresponding lake levels were determined as described in paragraph 2, above.

c. The discharges for the principal and emergency spillways for like elevations were summated for entry on the Y4 and Y5 cards.

4. <u>Lake Innsbrook Dam.</u>

a. The principal spillway for the Lake Innsbrook Dam consists of a 60-inch diameter drop inlet with a 36-inch diameter steel outlet pipe. Spillway releases for the drop inlet spillway were determined as described in paragraph 3a., above, with losses for the 36-inch outlet pipe totalling 3.27 velocity heads.

b. The emergency spillway for the Lake Innsbrook Dam consists of a broad-crested trapezoidal excavated earth section. Spillway

releases and corresponding lake levels were determined as described in paragraph 2, above.

c. The discharges for the principal and emergency spillways for like elevations were summated for entry on the Y4 and Y5 cards.

5. Spillway capacities for the various dams upstream of the Innsbrook group of dams were computed in a manner similar to those described in paragraphs 2 and 3, and corresponding spillway capacities were entered on the appropriate Y4 and Y5 cards.

6. For the Innsbrook group of dams and the upstream dams, the dam crest profiles are irregular, and flow over the dams cannot be determined by application of conventional weir formulas. For each dam, crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on $L and $V cards. The program assumes that flow over the dam crest section occurs at critical depth and computes internally the flow over the dam crest and adds this flow to the flow passing the spillways as entered on the Y4 and Y5 cards.

Group 1.

Lake Scheffborg - Ratios of PMF

```
1A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE SCHEFFBORG DAM
A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
B      288       0       5                                               4
B1       5
J        1       8       1
J1    0.10    0.15    0.20    0.25    0.30    0.40    0.50    1.00
K        0   RUNOFF                                        1
K1       INFLOW TO LAKE A
M        1       2   0.268                        1.0                    1
P        0    25.0     102     120     130
T                                                         -1     -93
W2            0.191
X     -1.0    -.10     2.0
K        1     DAM                                         1
K1       PMF ROUTED THRU LAKE A
Y                                1       1
Y1       1                                             41.37      -1
Y4     760     761     762     763     764     765     766     767     768     769
Y4     770
Y5       0     2.7    10.1    14.4    17.7    20.3    22.8    24.9    27.0    28.7
Y5    30.4
$A       0     7.3    16.4    28.9    46.2
$E     743     760     770     780     790
$$ 760.0
$D 765.5
$L [illegible]  204     431     513     588     700
$V 765.5   765.7   766.0   766.2   768.6   773.2
$B      10     0.5   750.5       1     760   765.5
K        0   RUNOFF                                        1
K1       INFLOW TO LAKE 30512
M        1       2   0.075                        1.0                    1
P        0    25.0     102     120     130
T                                                         -1     -91
W2            0.079
X      1.0    -.10     2.0
K        1     DAM                                         1
```

RATIOS OF PMF - LAKE SCHEFFBORG

```
K1      PMF ROUTED THRU LAKE 30512
Y                                     1       1
Y1     1                                                       62.53    -1
Y4 770.0    770.3   770.4   770.8   771.4   772.1   772.8   773.3   773.85   774.3
Y4 774.7    775.3   775.9   776.5   777.0   777.4  777.75
Y5     0        4      11      41     102     205     340     467     620     747
Y5   909     1146    1424    1748    2040    2230    2537
$A     0      6.7    11.2    17.7    26.4
$E   742      770     780     790     800
$$ 770.0
$D 772.4
$L     0       50      80     154     394     465     500     550     600
$V 772.4    773.4   773.7   773.9   774.3   774.5   776.4   779.7   782.0
K      0  RUNOFF                                            1
K1      INFLOW TO LAKE SCHEFFBORG
M      1        2   0.545                           1.0                     1
P      0     25.0     102     120     130
T                                                          -1     -90
W2          0.197
X   -1.0     -.10     2.0
K      3  COMBINE                                           1
K1       COMB OF OUTFLOW FROM A AND 30512 WITH RUNOFF TO SCHEFFBORG
K      1    DAM                                             1
K1      PMF ROUTED THRU LAKE SCHEFFBORG
Y                                     1       1
Y1     1                                                       78.83    -1
Y4 723.5   723.62  724.03  724.75  725.45  726.14  726.82  727.49  728.15  728.68
Y4728.91   729.49  730.09  730.81  731.54  732.27  732.99  733.72  734.44
Y5     0        1      23     113     248     422     635     887    1176    1438
Y5  1563     1912    2319    2874    3470    4111    4787    5499    6247
$A     0     11.0    17.3    31.2    54.3
$E   702    723.5     730     740     750
$$ 723.5
$D 728.4
$L     0       25     138     317     350     363     400
$V 723.4    728.5   728.8   728.9   729.1   729.5   737.2
K     99
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE SCHEFFBORG DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 283 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| JOPER | NWT | LROPT | TRACE |
|---|---|---|---|
| 5 | 0 | 0 | 0 |

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .18 .19 .50 1.00

**********    **********    **********    **********    **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO LAKE A

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| RUNOFF | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | .27 | 0.00 | .27 | 1.00 | 0.000 | 0 | 1 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|---|---|---|---|---|---|---|---|
| 0.00 | 25.00 | 102.00 | 120.00 | 130.00 | 0.00 | 0.00 | 0.00 |

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -93.00 | 0.00 | 0.00 |

CURVE NO = -93.00 WETNESS = -1.00 EFFECT CN = 93.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .19

RECESSION DATA
STRTQ= -1.00 QRCSN= -.10 RTIOR= 2.00

UNIT HYDROGRAPH 13 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .19 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 144. | 465. | 551. | 415. | 220. | 125. | 70. | 39. | 21. | 12. |
| 7. | 4. | 2. | | | | | | | |

# PMF - LAKE A

| Q | | | | | | END OF-PERIOD FLOW | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
| 1.01 | .05 | 1 | .01 | 0.00 | .01 | 0. | 1.01 | 12.05 | 145 | .21 | .21 | .00 | 149. |
| 1.01 | .10 | 2 | .01 | 0.00 | .01 | 0. | 1.01 | 12.10 | 146 | .21 | .21 | .00 | 218. |
| 1.01 | .15 | 3 | .01 | 0.00 | .01 | 0. | 1.01 | 12.15 | 147 | .21 | .21 | .00 | 299. |
| 1.01 | .20 | 4 | .01 | 0.00 | .01 | 0. | 1.01 | 12.20 | 148 | .21 | .21 | .00 | 361. |
| 1.01 | .25 | 5 | .01 | 0.00 | .01 | 0. | 1.01 | 12.25 | 149 | .21 | .21 | .00 | 394. |
| 1.01 | .30 | 6 | .01 | 0.00 | .01 | 0. | 1.01 | 12.30 | 150 | .21 | .21 | .00 | 412. |
| 1.01 | .35 | 7 | .01 | 0.00 | .01 | 0. | 1.01 | 12.35 | 151 | .21 | .21 | .00 | 423. |
| 1.01 | .40 | 8 | .01 | 0.00 | .01 | 0. | 1.01 | 12.40 | 152 | .21 | .21 | .00 | 429. |
| 1.01 | .45 | 9 | .01 | 0.00 | .01 | 0. | 1.01 | 12.45 | 153 | .21 | .21 | .00 | 432. |
| 1.01 | .50 | 10 | .01 | 0.00 | .01 | 0. | 1.01 | 12.50 | 154 | .21 | .21 | .00 | 435. |
| 1.01 | .55 | 11 | .01 | .00 | .01 | 0. | 1.01 | 12.55 | 155 | .21 | .21 | .00 | 436. |
| 1.01 | 1.00 | 12 | .01 | .00 | .01 | 0. | 1.01 | 13.00 | 156 | .21 | .21 | .00 | 437. |
| 1.01 | 1.05 | 13 | .01 | .00 | .01 | 0. | 1.01 | 13.05 | 157 | .26 | .25 | .00 | 443. |
| 1.01 | 1.10 | 14 | .01 | .00 | .01 | 1. | 1.01 | 13.10 | 158 | .26 | .25 | .00 | 463. |
| 1.01 | 1.15 | 15 | .01 | .00 | .01 | 2. | 1.01 | 13.15 | 159 | .26 | .25 | .00 | 486. |
| 1.01 | 1.20 | 16 | .01 | .00 | .01 | 2. | 1.01 | 13.20 | 160 | .26 | .25 | .00 | 504. |
| 1.01 | 1.25 | 17 | .01 | .00 | .01 | 3. | 1.01 | 13.25 | 161 | .26 | .25 | .00 | 514. |
| 1.01 | 1.30 | 18 | .01 | .00 | .01 | 4. | 1.01 | 13.30 | 162 | .26 | .25 | .00 | 519. |
| 1.01 | 1.35 | 19 | .01 | .00 | .01 | 5. | 1.01 | 13.35 | 163 | .26 | .25 | .00 | 522. |
| 1.01 | 1.40 | 20 | .01 | .00 | .01 | 6. | 1.01 | 13.40 | 164 | .26 | .25 | .00 | 524. |
| 1.01 | 1.45 | 21 | .01 | .00 | .01 | 6. | 1.01 | 13.45 | 165 | .26 | .25 | .00 | 525. |
| 1.01 | 1.50 | 22 | .01 | .00 | .01 | 7. | 1.01 | 13.50 | 166 | .26 | .25 | .00 | 526. |
| 1.01 | 1.55 | 23 | .01 | .00 | .01 | 8. | 1.01 | 13.55 | 167 | .26 | .25 | .00 | 526. |
| 1.01 | 2.00 | 24 | .01 | .00 | .01 | 8. | 1.01 | 14.00 | 168 | .26 | .25 | .00 | 526. |
| 1.01 | 2.05 | 25 | .01 | .01 | .01 | 9. | 1.01 | 14.05 | 169 | .32 | .32 | .00 | 536. |
| 1.01 | 2.10 | 26 | .01 | .01 | .01 | 10. | 1.01 | 14.10 | 170 | .32 | .32 | .00 | 565. |
| 1.01 | 2.15 | 27 | .01 | .01 | .01 | 10. | 1.01 | 14.15 | 171 | .32 | .32 | .00 | 600. |
| 1.01 | 2.20 | 28 | .01 | .01 | .01 | 11. | 1.01 | 14.20 | 172 | .32 | .32 | .00 | 627. |
| 1.01 | 2.25 | 29 | .01 | .01 | .01 | 11. | 1.01 | 14.25 | 173 | .32 | .32 | .00 | 641. |
| 1.01 | 2.30 | 30 | .01 | .01 | .01 | 12. | 1.01 | 14.30 | 174 | .32 | .32 | .00 | 649. |
| 1.01 | 2.35 | 31 | .01 | .01 | .01 | 12. | 1.01 | 14.35 | 175 | .32 | .32 | .00 | 654. |
| 1.01 | 2.40 | 32 | .01 | .01 | .01 | 13. | 1.01 | 14.40 | 176 | .32 | .32 | .00 | 656. |
| 1.01 | 2.45 | 33 | .01 | .01 | .01 | 13. | 1.01 | 14.45 | 177 | .32 | .32 | .00 | 658. |
| 1.01 | 2.50 | 34 | .01 | .01 | .01 | 13. | 1.01 | 14.50 | 178 | .32 | .32 | .00 | 658. |
| 1.01 | 2.55 | 35 | .01 | .01 | .01 | 14. | 1.01 | 14.55 | 179 | .32 | .32 | .00 | 659. |
| 1.01 | 3.00 | 36 | .01 | .01 | .01 | 14. | 1.01 | 15.00 | 180 | .32 | .32 | .00 | 659. |
| 1.01 | 3.05 | 37 | .01 | .01 | .01 | 15. | 1.01 | 15.05 | 181 | .19 | .19 | .00 | 642. |
| 1.01 | 3.10 | 38 | .01 | .01 | .01 | 15. | 1.01 | 15.10 | 182 | .39 | .39 | .00 | 611. |
| 1.01 | 3.15 | 39 | .01 | .01 | .01 | 15. | 1.01 | 15.15 | 183 | .39 | .39 | .00 | 633. |
| 1.01 | 3.20 | 40 | .01 | .01 | .01 | 16. | 1.01 | 15.20 | 184 | .58 | .58 | .00 | 716. |
| 1.01 | 3.25 | 41 | .01 | .01 | .01 | 16. | 1.01 | 15.25 | 185 | .68 | .68 | .00 | 872. |
| 1.01 | 3.30 | 42 | .01 | .01 | .01 | 16. | 1.01 | 15.30 | 186 | 1.65 | 1.64 | .00 | 1190. |
| 1.01 | 3.35 | 43 | .01 | .01 | .01 | 17. | 1.01 | 15.35 | 187 | 2.71 | 2.71 | .00 | 1943. |
| 1.01 | 3.40 | 44 | .01 | .01 | .01 | 17. | 1.01 | 15.40 | 188 | 1.07 | 1.06 | .00 | 2825. |
| 1.01 | 3.45 | 45 | .01 | .01 | .01 | 17. | 1.01 | 15.45 | 189 | .68 | .68 | .00 | 3042. |
| 1.01 | 3.50 | 46 | .01 | .01 | .01 | 17. | 1.01 | 15.50 | 190 | .58 | .58 | .00 | 2625. |
| 1.01 | 3.55 | 47 | .01 | .01 | .01 | 18. | 1.01 | 15.55 | 191 | .39 | .39 | .00 | 2028. |
| 1.01 | 4.00 | 48 | .01 | .01 | .00 | 18. | 1.01 | 16.00 | 192 | .39 | .39 | .00 | 1572. |
| 1.01 | 4.05 | 49 | .01 | .01 | .00 | 18. | 1.01 | 16.05 | 193 | .30 | .30 | .00 | 1238. |
| 1.01 | 4.10 | 50 | .01 | .01 | .00 | 18. | 1.01 | 16.10 | 194 | .30 | .30 | .00 | 996. |

PMF - LAKE A
END-OF-PERIOD FLOW (Cont'd)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 4.15 | 51 | .01 | .01 | .00 | 19. | 1.01 | 16.15 | 195 | .30 | .30 | .00 | 837. |
| 1.01 | 4.20 | 52 | .01 | .01 | .00 | 19. | 1.01 | 16.20 | 196 | .30 | .30 | .00 | 739. |
| 1.01 | 4.25 | 53 | .01 | .01 | .00 | 19. | 1.01 | 16.25 | 197 | .30 | .30 | .00 | 685. |
| 1.01 | 4.30 | 54 | .01 | .01 | .00 | 19. | 1.01 | 16.30 | 198 | .30 | .30 | .00 | 655. |
| 1.01 | 4.35 | 55 | .01 | .01 | .00 | 19. | 1.01 | 16.35 | 199 | .30 | .30 | .00 | 636. |
| 1.01 | 4.40 | 56 | .01 | .01 | .00 | 20. | 1.01 | 16.40 | 200 | .30 | .30 | .00 | 625. |
| 1.01 | 4.45 | 57 | .01 | .01 | .00 | 20. | 1.01 | 16.45 | 201 | .30 | .30 | .00 | 620. |
| 1.01 | 4.50 | 58 | .01 | .01 | .00 | 20. | 1.01 | 16.50 | 202 | .30 | .30 | .00 | 618. |
| 1.01 | 4.55 | 59 | .01 | .01 | .00 | 20. | 1.01 | 16.55 | 203 | .30 | .30 | .00 | 617. |
| 1.01 | 5.00 | 60 | .01 | .01 | .00 | 20. | 1.01 | 17.00 | 204 | .30 | .30 | .00 | 617. |
| 1.01 | 5.05 | 61 | .01 | .01 | .00 | 21. | 1.01 | 17.05 | 205 | .23 | .23 | .00 | 607. |
| 1.01 | 5.10 | 62 | .01 | .01 | .00 | 21. | 1.01 | 17.10 | 206 | .23 | .23 | .00 | 578. |
| 1.01 | 5.15 | 63 | .01 | .01 | .00 | 21. | 1.01 | 17.15 | 207 | .23 | .23 | .00 | 543. |
| 1.01 | 5.20 | 64 | .01 | .01 | .00 | 21. | 1.01 | 17.20 | 208 | .23 | .23 | .00 | 516. |
| 1.01 | 5.25 | 65 | .01 | .01 | .00 | 21. | 1.01 | 17.25 | 209 | .23 | .23 | .00 | 502. |
| 1.01 | 5.30 | 66 | .01 | .01 | .00 | 21. | 1.01 | 17.30 | 210 | .23 | .23 | .00 | 494. |
| 1.01 | 5.35 | 67 | .01 | .01 | .00 | 21. | 1.01 | 17.35 | 211 | .23 | .23 | .00 | 490. |
| 1.01 | 5.40 | 68 | .01 | .01 | .00 | 22. | 1.01 | 17.40 | 212 | .23 | .23 | .00 | 488. |
| 1.01 | 5.45 | 69 | .01 | .01 | .00 | 22. | 1.01 | 17.45 | 213 | .23 | .23 | .00 | 486. |
| 1.01 | 5.50 | 70 | .01 | .01 | .00 | 22. | 1.01 | 17.50 | 214 | .23 | .23 | .00 | 485. |
| 1.01 | 5.55 | 71 | .01 | .01 | .00 | 22. | 1.01 | 17.55 | 215 | .23 | .23 | .00 | 485. |
| 1.01 | 6.00 | 72 | .01 | .01 | .00 | 22. | 1.01 | 18.00 | 216 | .23 | .23 | .00 | 485. |
| 1.01 | 6.05 | 73 | .06 | .05 | .01 | 28. | 1.01 | 18.05 | 217 | .02 | .02 | .00 | 454. |
| 1.01 | 6.10 | 74 | .06 | .05 | .01 | 46. | 1.01 | 18.10 | 218 | .02 | .02 | .00 | 355. |
| 1.01 | 6.15 | 75 | .06 | .05 | .01 | 68. | 1.01 | 18.15 | 219 | .02 | .02 | .00 | 293. |
| 1.01 | 6.20 | 76 | .06 | .05 | .01 | 85. | 1.01 | 18.20 | 220 | .02 | .02 | .00 | 273. |
| 1.01 | 6.25 | 77 | .06 | .05 | .01 | 94. | 1.01 | 18.25 | 221 | .02 | .02 | .00 | 255. |
| 1.01 | 6.30 | 78 | .06 | .05 | .01 | 101. | 1.01 | 18.30 | 222 | .02 | .02 | .00 | 238. |
| 1.01 | 6.35 | 79 | .06 | .05 | .01 | 105. | 1.01 | 18.35 | 223 | .02 | .02 | .00 | 222. |
| 1.01 | 6.40 | 80 | .06 | .05 | .01 | 108. | 1.01 | 18.40 | 224 | .02 | .02 | .00 | 207. |
| 1.01 | 6.45 | 81 | .06 | .05 | .01 | 110. | 1.01 | 18.45 | 225 | .02 | .02 | .00 | 193. |
| 1.01 | 6.50 | 82 | .06 | .05 | .01 | 111. | 1.01 | 18.50 | 226 | .02 | .02 | .00 | 180. |
| 1.01 | 6.55 | 83 | .06 | .05 | .01 | 113. | 1.01 | 18.55 | 227 | .02 | .02 | .00 | 168. |
| 1.01 | 7.00 | 84 | .06 | .06 | .01 | 114. | 1.01 | 19.00 | 228 | .02 | .02 | .00 | 157. |
| 1.01 | 7.05 | 85 | .06 | .06 | .01 | 115. | 1.01 | 19.05 | 229 | .02 | .02 | .00 | 146. |
| 1.01 | 7.10 | 86 | .06 | .06 | .01 | 115. | 1.01 | 19.10 | 230 | .02 | .02 | .00 | 137. |
| 1.01 | 7.15 | 87 | .06 | .06 | .01 | 116. | 1.01 | 19.15 | 231 | .02 | .02 | .00 | 127. |
| 1.01 | 7.20 | 88 | .06 | .06 | .01 | 117. | 1.01 | 19.20 | 232 | .02 | .02 | .00 | 119. |
| 1.01 | 7.25 | 89 | .06 | .06 | .01 | 118. | 1.01 | 19.25 | 233 | .02 | .02 | .00 | 111. |
| 1.01 | 7.30 | 90 | .06 | .06 | .00 | 118. | 1.01 | 19.30 | 234 | .02 | .02 | .00 | 103. |
| 1.01 | 7.35 | 91 | .06 | .06 | .00 | 119. | 1.01 | 19.35 | 235 | .02 | .02 | .00 | 97. |
| 1.01 | 7.40 | 92 | .06 | .06 | .00 | 119. | 1.01 | 19.40 | 236 | .02 | .02 | .00 | 90. |
| 1.01 | 7.45 | 93 | .06 | .06 | .00 | 120. | 1.01 | 19.45 | 237 | .02 | .02 | .00 | 84. |
| 1.01 | 7.50 | 94 | .06 | .06 | .00 | 120. | 1.01 | 19.50 | 238 | .02 | .02 | .00 | 78. |
| 1.01 | 7.55 | 95 | .06 | .06 | .00 | 121. | 1.01 | 19.55 | 239 | .02 | .02 | .00 | 73. |
| 1.01 | 8.00 | 96 | .06 | .06 | .00 | 121. | 1.01 | 20.00 | 240 | .02 | .02 | .00 | 68. |
| 1.01 | 8.05 | 97 | .06 | .06 | .00 | 121. | 1.01 | 20.05 | 241 | .02 | .02 | .00 | 64. |
| 1.01 | 8.10 | 98 | .06 | .06 | .00 | 122. | 1.01 | 20.10 | 242 | .02 | .02 | .00 | 59. |
| 1.01 | 8.15 | 99 | .06 | .06 | .00 | 122. | 1.01 | 20.15 | 243 | .02 | .02 | .00 | 55. |
| 1.01 | 8.20 | 100 | .06 | .06 | .00 | 122. | 1.01 | 20.20 | 244 | .02 | .02 | .00 | 52. |
| 1.01 | 8.25 | 101 | .06 | .06 | .00 | 123. | 1.01 | 20.25 | 245 | .02 | .02 | .00 | 48. |
| 1.01 | 8.30 | 102 | .06 | .06 | .00 | 123. | 1.01 | 20.30 | 246 | .02 | .02 | .00 | 45. |
| 1.01 | 8.35 | 103 | .06 | .06 | .00 | 123. | 1.01 | 20.35 | 247 | .02 | .02 | .00 | 43. |

PMF - LAKE A
END-OF-PERIOD FLOW (Cont'd)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 8.40 | 104 | .06 | .06 | .00 | 123. | | 1.01 | 20.40 | 248 | .02 | .02 | .00 | 43. |
| 1.01 | 8.45 | 105 | .06 | .06 | .00 | 124. | | 1.01 | 20.45 | 249 | .02 | .02 | .00 | 43. |
| 1.01 | 8.50 | 106 | .06 | .06 | .00 | 124. | | 1.01 | 20.50 | 250 | .02 | .02 | .00 | 43. |
| 1.01 | 8.55 | 107 | .06 | .06 | .00 | 124. | | 1.01 | 20.55 | 251 | .02 | .02 | .00 | 43. |
| 1.01 | 9.00 | 108 | .06 | .06 | .00 | 124. | | 1.01 | 21.00 | 252 | .02 | .02 | .00 | 43. |
| 1.01 | 9.05 | 109 | .06 | .06 | .00 | 124. | | 1.01 | 21.05 | 253 | .02 | .02 | .00 | 43. |
| 1.01 | 9.10 | 110 | .06 | .06 | .00 | 124. | | 1.01 | 21.10 | 254 | .02 | .02 | .00 | 43. |
| 1.01 | 9.15 | 111 | .06 | .06 | .00 | 125. | | 1.01 | 21.15 | 255 | .02 | .02 | .00 | 43. |
| 1.01 | 9.20 | 112 | .06 | .06 | .00 | 125. | | 1.01 | 21.20 | 256 | .02 | .02 | .00 | 43. |
| 1.01 | 9.25 | 113 | .06 | .06 | .00 | 125. | | 1.01 | 21.25 | 257 | .02 | .02 | .00 | 43. |
| 1.01 | 9.30 | 114 | .06 | .06 | .00 | 125. | | 1.01 | 21.30 | 258 | .02 | .02 | .00 | 43. |
| 1.01 | 9.35 | 115 | .06 | .06 | .00 | 125. | | 1.01 | 21.35 | 259 | .02 | .02 | .00 | 43. |
| 1.01 | 9.40 | 116 | .06 | .06 | .00 | 125. | | 1.01 | 21.40 | 260 | .02 | .02 | .00 | 43. |
| 1.01 | 9.45 | 117 | .06 | .06 | .00 | 126. | | 1.01 | 21.45 | 261 | .02 | .02 | .00 | 43. |
| 1.01 | 9.50 | 118 | .06 | .06 | .00 | 126. | | 1.01 | 21.50 | 262 | .02 | .02 | .00 | 43. |
| 1.01 | 9.55 | 119 | .06 | .06 | .00 | 126. | | 1.01 | 21.55 | 263 | .02 | .02 | .00 | 43. |
| 1.01 | 10.00 | 120 | .06 | .06 | .00 | 126. | | 1.01 | 22.00 | 264 | .02 | .02 | .00 | 43. |
| 1.01 | 10.05 | 121 | .06 | .06 | .00 | 126. | | 1.01 | 22.05 | 265 | .02 | .02 | .00 | 43. |
| 1.01 | 10.10 | 122 | .06 | .06 | .00 | 126. | | 1.01 | 22.10 | 266 | .02 | .02 | .00 | 43. |
| 1.01 | 10.15 | 123 | .06 | .06 | .00 | 126. | | 1.01 | 22.15 | 267 | .02 | .02 | .00 | 43. |
| 1.01 | 10.20 | 124 | .06 | .06 | .00 | 126. | | 1.01 | 22.20 | 268 | .02 | .02 | .00 | 43. |
| 1.01 | 10.25 | 125 | .06 | .06 | .00 | 126. | | 1.01 | 22.25 | 269 | .02 | .02 | .00 | 43. |
| 1.01 | 10.30 | 126 | .06 | .06 | .00 | 126. | | 1.01 | 22.30 | 270 | .02 | .02 | .00 | 43. |
| 1.01 | 10.35 | 127 | .06 | .06 | .00 | 127. | | 1.01 | 22.35 | 271 | .02 | .02 | .00 | 43. |
| 1.01 | 10.40 | 128 | .06 | .06 | .00 | 127. | | 1.01 | 22.40 | 272 | .02 | .02 | .00 | 43. |
| 1.01 | 10.45 | 129 | .06 | .06 | .00 | 127. | | 1.01 | 22.45 | 273 | .02 | .02 | .00 | 43. |
| 1.01 | 10.50 | 130 | .06 | .06 | .00 | 127. | | 1.01 | 22.50 | 274 | .02 | .02 | .00 | 43. |
| 1.01 | 10.55 | 131 | .06 | .06 | .00 | 127. | | 1.01 | 22.55 | 275 | .02 | .02 | .00 | 43 |
| 1.01 | 11.00 | 132 | .06 | .06 | .00 | 127. | | 1.01 | 23.00 | 276 | .02 | .02 | .00 | 43. |
| 1.01 | 11.05 | 133 | .06 | .06 | .00 | 127. | | 1.01 | 23.05 | 277 | .02 | .02 | .00 | 43. |
| 1.01 | 11.10 | 134 | .06 | .06 | .00 | 127. | | 1.01 | 23.10 | 278 | .02 | .02 | .00 | 43. |
| 1.01 | 11.15 | 135 | .06 | .06 | .00 | 127. | | 1.01 | 23.15 | 279 | .02 | .02 | .00 | 43. |
| 1.01 | 11.20 | 136 | .06 | .06 | .00 | 127. | | 1.01 | 23.20 | 280 | .02 | .02 | .00 | 43. |
| 1.01 | 11.25 | 137 | .06 | .06 | .00 | 127. | | 1.01 | 23.25 | 281 | .02 | .02 | .00 | 43. |
| 1.01 | 11.30 | 138 | .06 | .06 | .00 | 127. | | 1.01 | 23.30 | 282 | .02 | .02 | .00 | 43. |
| 1.01 | 11.35 | 139 | .06 | .06 | .00 | 127. | | 1.01 | 23.35 | 283 | .02 | .02 | .00 | 43. |
| 1.01 | 11.40 | 140 | .06 | .06 | .00 | 127. | | 1.01 | 23.40 | 284 | .02 | .02 | .00 | 43. |
| 1.01 | 11.45 | 141 | .06 | .06 | .00 | 127. | | 1.01 | 23.45 | 285 | .02 | .02 | .00 | 43. |
| 1.01 | 11.50 | 142 | .06 | .06 | .00 | 127. | | 1.01 | 23.50 | 286 | .02 | .02 | .00 | 43. |
| 1.01 | 11.55 | 143 | .06 | .06 | .00 | 127. | | 1.01 | 23.55 | 287 | .02 | .02 | .00 | 43. |
| 1.01 | 12.00 | 144 | .06 | .06 | .00 | 128. | | 1.02 | 0.00 | 288 | .02 | .02 | .00 | 43. |
| | | | | | | | | | | SUM | 32.50 | 31.61 | .89 | 67564. |
| | | | | | | | | | | | ( 825.) | ( 803.) | ( 23.) | ( 1913.2( |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3042. | 726. | 235. | 235. | 67549. |
| CMS | 86. | 21. | 7. | 7. | 1913. |
| INCHES | | 25.19 | 32.56 | 32.56 | 32.56 |
| MM | | 639.75 | 827.14 | 827.14 | 827.14 |
| AC-FT | | 360. | 465. | 465. | 465. |
| THOUS CU M | | 444. | 574. | 574. | 574. |

LAKE A

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 16. | 29. | 46. |
| CAPACITY= | 0. | 41. | 157. | 380. | 753. |
| ELEVATION= | 743. | 760. | 770. | 780. | 790. |

LAKE 30512

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 11. | 18. | 26. |
| CAPACITY= | 0. | 63. | 151. | 294. | 513. |
| ELEVATION= | 742. | 770. | 780. | 790. | 800. |

LAKE SCHEFFBORG

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 11. | 17. | 31. | 54. |
| CAPACITY= | 0. | 79. | 170. | 409. | 831. |
| ELEVATION= | 702. | 724. | 730. | 740. | 750. |

## SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE A

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 760.00 | 760.00 | 765.50 |
| STORAGE | 41. | 41. | 94. |
| OUTFLOW | 0. | 0. | 22. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 764.14 | 0.00 | 78. | 18. | 0.00 | 18.83 | 0.00 |
| .15 | 765.54 | .04 | 94. | 1291. | .27 | 18.42 | 17.42 |
| .20 | 765.85 | .35 | 98. | 1405. | .46 | 16.92 | 15.92 |
| .25 | 766.15 | .65 | 101. | 1500. | .56 | 16.67 | 15.67 |
| .30 | 765.82 | .32 | 97. | 1778. | .71 | 16.25 | 15.25 |
| .40 | 765.76 | .26 | 97. | 1531. | .48 | 15.33 | 14.33 |
| .50 | 765.77 | .27 | 97. | 1580. | .50 | 14.67 | 13.67 |
| 1.00 | 765.57 | .07 | 94. | 1910. | .33 | 15.92 | 11.50 |

## SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE 30512

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 770.00 | 770.00 | 772.40 |
| STORAGE | 63. | 63. | 80. |
| OUTFLOW | 0. | 0. | 263. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 770.72 | 0.00 | 67. | 35. | 0.00 | 15.92 | 0.00 |
| .15 | 770.95 | 0.00 | 69. | 57. | 0.00 | 15.92 | 0.00 |
| .20 | 771.17 | 0.00 | 71. | 79. | 0.00 | 15.83 | 0.00 |
| .25 | 771.39 | 0.00 | 72. | 101. | 0.00 | 15.83 | 0.00 |
| .30 | 771.58 | 0.00 | 74. | 128. | 0.00 | 15.83 | 0.00 |
| .40 | 771.94 | 0.00 | 76. | 181. | 0.00 | 15.83 | 0.00 |
| .50 | 772.27 | 0.00 | 79. | 238. | 0.00 | 15.83 | 0.00 |
| 1.00 | 773.55 | 1.15 | 89. | 620. | .92 | 15.75 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE SCHEFFBORG

| ........ | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 723.50 | 723.50 | 728.40 |
| STORAGE | 79. | 79. | 144. |
| OUTFLOW | 0. | 0. | 1300. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 725.81 | 0.00 | 107. | 338. | 0.00 | 16.08 | 0.00 |
| .15 | 727.78 | 0.00 | 134. | 1015. | 0.00 | 18.58 | 0.00 |
| .20 | 728.57 | .17 | 146. | 1389. | .33 | 17.00 | 0.00 |
| .25 | 729.00 | .60 | 153. | 1748. | 1.08 | 16.75 | 0.00 |
| .30 | 729.47 | 1.07 | 161. | 2542. | 1.08 | 16.08 | 0.00 |
| .40 | 729.86 | 1.46 | 168. | 3413. | 1.58 | 15.83 | 0.00 |
| .50 | 730.01 | 1.61 | 170. | 3796. | 2.50 | 15.83 | 0.00 |
| 1.00 | 731.33 | 2.93 | 194. | 7859. | 6.00 | 15.83 | 0.00 |

Group 2.

Lake Lucern - Ratios of PMF

```
A1        ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2        HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE LUCERN DAM
A3        RATIOS OF PMF ROUTED THROUGH RESERVOIR
B      208       0       5                                                   4
B1       5
J        1       8       1
J1    0.10    0.15    0.20    0.25    0.30    0.40    0.50    1.00
K        0  RUNOFF                                       1
K1        INFLOW TO LAKE A
M        1       2   0.268                     1.0                           1
P        0    25.0     102     120     130
T                                                       -1     -93
W2            0.191
X     -1.0    -.10     2.0
K        1     DAM                                       1
K1        PMF ROUTED THRU LAKE A
Y                                1       1
Y1       1                                           41.37      -1
Y4     760     761     762     763     764     765     766     767     768     769
Y4     770
Y5       0     2.7    10.1    14.4    17.7    20.3    22.0    24.9    27.0    28.7
Y5    30.4
$A       0     7.3    16.4    28.9    46.2
$E     743     760     770     780     790
$$   760.0
$D   765.5
$L      64     204     431     513     580     700
$V   765.5   765.7   766.0   766.2   768.6   773.2
$B      10     0.5   750.5       1     760   765.5
K        0  RUNOFF                                       1
K1        INFLOW TO LAKE 30512
M        1       2   0.075                     1.0                           1
P        0    25.0     102     120     130
T                                                        1     -91
W2            0.079
X     -1.0    -.10     2.0
K        1     DAM                                       1
```

RATIOS OF PMF - LAKE LUCERN

```
K1        PMF ROUTED THRU LAKE 30512
Y                                    1       1
Y1    1                                                      67.53    -1
Y4 770.0    770.3    770.4    770.8    771.4    772.1    772.8    773.3  773.85    774.3
Y4 774.7    775.3    775.9    776.5    777.0    777.4   777.75
Y5     0        4       11       41      102      205      340      467     620      747
Y5   909     1146     1424     1748     2040     2280     2537
$A     0      6.7     11.2     17.7     26.4
$E   742      770      780      790      800
$$ 770.0
$D 772.4
$L     0       50       80      154      394      445      500      550     600
$V 772.4    773.4    773.7    773.9    774.3    774.5    776.4    779.7   782.0
K      0  RUNOFF                                               1
K1        INFLOW TO LAKE SCHEFFBORG
M      1        2    0.545                         1.0                       1
P      0     25.0      102      120      130
T                                                              1      -90
W2           0.197
X   -1.0     -.10      2.0
K      3 COMBINE                                               1
K1         COMB OF OUTFLOW FROM A AND 30512 WITH RUNOFF TO SCHEFFBORG
K      1     DAM                                               1
K1        PMF ROUTED THRU LAKE SCHEFFBORG
Y                                    1       1
Y1    1                                                      78.83    -1
Y4 723.5   723.62   724.03   724.75   725.45   726.14   726.82   727.49  728.15   728.68
Y4728.91   729.49   730.09   730.81   731.54   732.27   732.99   733.72  734.44
Y5     0        1       23      113      248      422      635      887    1174     1438
Y5  1563     1912     2319     2874     3473     4111     4787     5499    6247
$A     0     11.0     17.3     31.2     54.3
$E   702    723.5      730      740      750
$$ 723.5
$D 728.4
$L     0       25      138      317      350      343      400
$V 728.4    728.5    728.8    728.9    729.1    729.5    737.2
$B    10      0.5    710.0        1    723.5    728.4
K      0  RUNOFF                                               1
K1        INFLOW TO LAKE B
M      1        2    0.086                         1.0                       1
P      0     25.0      102      120      130
T                                                             -1      -93
W2           0.058
X   -1.0     -.10      2.0
```

RATIOS OF PMF - LAKE LUCERN

```
K1      PMF ROUTED THRU LAKE B
Y                                  1        1
Y1      1                                                  83.85      -1
Y4 805.5   805.76   806.47   806.88   807.35   807.84   808.20   808.78   809.44   810.09
Y4810.74   811.39   812.03   812.66   813.30
Y5      0        6       70      132      234      384      530      835     1288     1839
Y5   2492     3250     4117     5099     6196
$A      0     12.9     17.4     31.0
$E    786    805.5      810      820
$$ 805.5
$D 808.1
$L      0       23      207      353      506      634      790
$V 808.1    808.2    809.2    809.8    810.5    810.9    814.0
K       1REACH W                                             1
K1      STREAM ROUTING-LAKE B TO LAKE LUCERN
Y                                  1        1
Y1      1
Y6 0.050    0.035    0.050      687      707     7400   0.0103
Y7      0      732      250      712      540      692      545      687      555      687
Y7    560      692      750      712      900      732
K       0  RUNOFF                                            1
K1      INFLOW TO LAKE LUCERN
M       1        2    1.275                        1.0                         1
P       0     25.0      102      120      130
T                                                            -1      -91
W2           0.551
X    -1.0     -.10      2.0
K       3    COMB.                                           1
K1      COMB. OUTFLOW FROM SCHEFFBORG AND B WITH RUNOFF TO LUCERN
K       1     DAM                                            1
K1      PMF ROUTED THRU LAKE LUCERN
Y                                  1        1
Y1      1                                                  [illegible]      -1
Y4 692.0    692.5    693.0    693.4   694.07   694.42   694.95   695.47   696.16   696.85
Y4697.39   697.91   698.43   698.95   699.51   700.00   700.74   701.34   702.03
Y5      0       22       53       54       98      191      409      720     1300     2029
Y5   2702     3446     4282     5210     6351     7569     8868    10606    12446
$A      0     42.2     57.9     80.1    103.8
$E    668      692      700      710      720
$$ 692.0
$D 697.2
$L      0      258      389      554      575      625      675      696      701
$V 697.2    697.5    697.7    697.9    698.2    699.5    702.6    702.9    708.9
K      99
```

LAKE A

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 16. | 29. | 46. |
| CAPACITY= | 0. | 41. | 157. | 380. | 753. |
| ELEVATION= | 743. | 760. | 770. | 780. | 790. |

LAKE 30512

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 11. | 18. | 26. |
| CAPACITY= | 0. | 63. | 151. | 294. | 513. |
| ELEVATION= | 742. | 770. | 780. | 790. | 800. |

LAKE SCHEFFBORG

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 11. | 17. | [illegible] | 54. |
| CAPACITY= | 0. | 79. | 170. | 409. | [illegible] |
| ELEVATION= | 702. | 724. | 730. | 740. | 750. |

LAKE B

| | | | | |
|---|---|---|---|---|
| SURFACE AREA= | 0. | 13. | 17. | 31. |
| CAPACITY= | 0. | 84. | 150. | [illegible] |
| ELEVATION= | 786. | 800. | [illegible] | 820. |

LAKE LUCERN

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 42. | 58. | 80. | 104. |
| CAPACITY= | 0. | 338. | 736. | 1423. | 2340. |
| ELEVATION= | 668. | 692. | 700. | 710. | 720. |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE A

| ....... | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 760.00 | 760.00 | 765.50 |
| STORAGE | 41. | 41. | 94. |
| OUTFLOW | 0. | 0. | 22. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 764.14 | 0.00 | 78. | 18. | 0.00 | 18.83 | 0.00 |
| .15 | 765.54 | .04 | 94. | 1291. | .27 | 18.42 | 17.42 |
| .20 | 765.85 | .35 | 98. | 1405. | .46 | 16.92 | 15.92 |
| .25 | 766.15 | .65 | 101. | 1500. | .56 | 16.67 | 15.67 |
| .30 | 765.82 | .32 | 97. | 1778. | .71 | 16.25 | 15.25 |
| .40 | 765.76 | .26 | 97. | 1531. | .48 | 15.33 | 14.33 |
| .50 | 765.77 | .27 | 97. | 1580. | .50 | 14.67 | 13.67 |
| 1.00 | 765.57 | .07 | 94. | 1910. | .33 | 15.92 | 11.50 |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE 30512

| ....... | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 770.00 | 770.00 | 772.40 |
| STORAGE | 63. | 63. | 80. |
| OUTFLOW | 0. | 0. | 263. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 770.72 | 0.00 | 67. | 35. | 0.00 | 15.92 | 0.00 |
| .15 | 770.95 | 0.00 | 69. | 57. | 0.00 | 15.92 | 0.00 |
| .20 | 771.17 | 0.00 | 71. | 79. | 0.00 | 15.83 | 0.00 |
| .25 | 771.39 | 0.00 | 72. | 101. | 0.00 | 15.83 | 0.00 |
| .30 | 771.58 | 0.00 | 74. | 128. | 0.00 | 15.83 | 0.00 |
| .40 | 771.94 | 0.00 | 76. | 181. | 0.00 | 15.83 | 0.00 |
| .50 | 772.27 | 0.00 | 79. | 238. | 0.00 | 15.83 | 0.00 |
| 1.00 | 773.55 | 1.15 | 89. | 620. | .92 | 15.75 | 0.00 |

## SUMMARY OF DAM SAFETY ANALYSIS

### PMF - LAKE SCHEFFBORG

| ....... | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 723.50 | 723.50 | 728.40 |
| STORAGE | 79. | 79. | 144. |
| OUTFLOW | 0. | 0. | 1300. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 725.81 | 0.00 | 107. | 338. | 0.00 | 16.08 | 0.00 |
| .15 | 727.78 | 0.00 | 134. | 1015. | 0.00 | 18.58 | [illegible].00 |
| .20 | 728.56 | .16 | 146. | 2111. | .29 | 17.92 | 16.92 |
| .25 | 728.49 | .09 | 145. | 2755. | .42 | 17.08 | 16.08 |
| .30 | 729.37 | .97 | 159. | 2857. | .67 | 16.48 | 15.83 |
| .40 | 729.09 | .69 | 155. | 4004. | .87 | 15.[illegible] | 15.17 |
| .50 | 729.09 | .69 | 155. | 3440. | .56 | 15.92 | 14.50 |
| 1.00 | 729.27 | .87 | 158. | 6693. | .90 | 15.92 | 12.50 |

## SUMMARY OF DAM SAFETY ANALYSIS

### PMF - LAKE B

| ....... | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 805.50 | 805.50 | 808.10 |
| STORAGE | 84. | 84. | 121. |
| OUTFLOW | 0. | 0. | 409. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 806.03 | 0.00 | 91. | 30. | 0.00 | 16.00 | 0.00 |
| .15 | 806.22 | 0.00 | 93. | 47. | 0.00 | 15.92 | 0.00 |
| .20 | 806.40 | 0.00 | 96. | 64. | 0.00 | 15.92 | 0.00 |
| .25 | 806.58 | 0.00 | 98. | 86. | 0.00 | 15.92 | 0.00 |
| .30 | 806.74 | 0.00 | 101. | 110. | 0.00 | 15.92 | 0.00 |
| .40 | 807.04 | 0.00 | 105. | 166. | 0.00 | 15.83 | 0.00 |
| .50 | 807.31 | 0.00 | 109. | 224. | 0.00 | 15.83 | 0.00 |
| 1.00 | 808.32 | .22 | 124. | 597. | .42 | 15.75 | 0.00 |

PLAN 1 STATION ACH W
PMF - CHANNEL TO LAKE LUCERN

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|
| .10 | 27. | 687.6 | 16.83 |
| .15 | 42. | 687.9 | 16.75 |
| .20 | 59. | 688.2 | 16.50 |
| .25 | 78. | 688.4 | 16.33 |
| .30 | 100. | 688.6 | 16.25 |
| .40 | 146. | 689.1 | 16.17 |
| .50 | 201. | 689.5 | 16.17 |
| 1.00 | 514. | 691.2 | 16.00 |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE LUCERN

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 692.00 | 692.00 | 697.20 |
| STORAGE | 338. | 338. | 582. |
| OUTFLOW | 0. | 0. | 2465. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 695.38 | 0.00 | 491. | 671. | 0.00 | 16.83 | 0.00 |
| .15 | 696.11 | 0.00 | 527. | 1267. | 0.00 | 16.58 | 0.00 |
| .20 | 697.14 | 0.00 | 579. | 2395. | 0.00 | 18.00 | 0.00 |
| .25 | 697.85 | .65 | 617. | 3695. | 1.58 | 17.08 | 0.00 |
| .30 | 698.20 | 1.00 | 636. | 4869. | 1.75 | 16.50 | 0.00 |
| .40 | 698.74 | 1.54 | 665. | 7158. | 2.25 | 16.17 | 0.00 |
| .50 | 698.80 | 1.60 | 668. | 7416. | 3.50 | 16.17 | 0.00 |
| 1.00 | 700.05 | 2.85 | 739. | 14701. | 6.17 | 16.17 | 0.00 |

Group 3.

Lake Innsbrook - Ratios of PMF

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1A1 | ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF | | | | | | | | | |
| A2 | HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE INNSBROOK DAM | | | | | | | | | |
| A3 | RATIOS OF PMF ROUTED THROUGH RESERVOIR | | | | | | | | | |
| B | 288 | 0 | 5 | | | | | | 4 | |
| B1 | 5 | | | | | | | | | |
| J | 1 | 8 | 1 | | | | | | | |
| J1 | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 | 0.40 | 0.50 | 1.00 | | |
| K | 0 | RUNOFF | | | | | 1 | | | |
| K1 | INFLOW TO LAKE A | | | | | | | | | |
| M | 1 | 2 | 0.268 | | | 1.0 | | | 1 | |
| P | 0 | 25.0 | 102 | 120 | 130 | | | | | |
| T | | | | | | | -1 | -93 | | |
| W2 | | 0.191 | | | | | | | | |
| X | -1.0 | -.10 | 2.0 | | | | | | | |
| K | 1 | DAM | | | | | 1 | | | |
| K1 | PMF ROUTED THRU LAKE A | | | | | | | | | |
| Y | | | | 1 | 1 | | | | | |
| Y1 | 1 | | | | | | 41.37 | -1 | | |
| Y4 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 |
| Y4 | 770 | | | | | | | | | |
| Y5 | 0 | 2.7 | 10.1 | 14.4 | 17.7 | 20.[illegible] | 22.8 | 24.[illegible] | 27.0 | 28.7 |
| Y5 | 30.4 | | | | | | | | | |
| $A | 0 | 7.3 | 16.4 | 28.9 | 46.[illegible] | | | | | |
| $E | 743 | 760 | 770 | 780 | 790 | | | | | |
| $$ | 760.0 | | | | | | | | | |
| $D | 765.5 | | | | | | | | | |
| $L | 44 | 204 | [illegible] | 513 | 588 | [illegible] | | | | |
| $V | 765.5 | 765.7 | 766.0 | 766.[illegible] | 768.4 | 773.[illegible] | | | | |
| $[illegible] | 1[illegible] | [illegible].5 | 750.5 | 1 | 770 | 775.5 | | | | |
| K | 0 | RUNOFF | | | | | 1 | | | |
| K1 | INFLOW TO LAKE 30512 | | | | | | | | | |
| M | 1 | 2 | 0.075 | | | 1.0 | | | 1 | |
| P | 0 | 25.0 | 102 | 120 | 130 | | | | | |
| T | | | | | | | 1 | -91 | | |
| W2 | | 0.079 | | | | | | | | |
| X | -1.0 | -.10 | 2.0 | | | | | | | |
| K | 1 | DAM | | | | | 1 | | | |

RATIOS OF PMF - LAKE HINSBROOK

```
K1       PMF ROUTED THRU LAKE 30512
Y                                  1       1
Y1      1                                                          62.53      -1
Y4 770.0    770.3    770.4    770.8    771.4    772.1    772.8    773.3   773.85    774.3
Y4 774.7    775.3    775.9    776.5    777.0    777.4   777.75
Y5      0        4       11       41      102      205      340      467      620      747
Y5    909     1146     1424     1748     2040     2280     2537
$A      0      6.7     11.2     17.7     26.4
$E    742      770      780      790      800
$$ 770.0
$D 772.4
$L      0       50       80      154      394      465      500      550      600
$V 772.4    773.4    773.7    773.9    774.3    774.5    776.4    779.7    782.0
K       0  RUNOFF                                                    1
K1       INFLOW TO LAKE SCHEFFBORG
M       1        2    0.545                          1.0                          1
P       0     25.0      102      120      130
T                                                            -1      -90
W2           0.197
X    -1.0     -.10      2.0
K       3 COMBINE                                                    1
K1        COMB OF OUTFLOW FROM A AND 30512 WITH RUNOFF TO SCHEFFBORG
K       1     DAM                                                    1
K1       PMF ROUTED THRU LAKE SCHEFFBORG
Y                                  1       1
Y1      1                                                          78.83      -1
Y4 723.5   723.62   724.03   724.75   725.45   726.14   726.82   727.49   728.15   728.68
Y4728.91   729.49   730.09   730.81   731.54   732.27   732.99   733.72   734.44
Y5      0        1       23      113      248      422      635      887     1176     1438
Y5   1563     1912     2319     2874     3473     4111     4787     5499     6247
$A      0     11.0     17.3     31.2     54.1
$E    702    723.5      730      740      750
$$ 723.5
$D 728.4
$L      0       25      138      317      350      363      400
$V 728.4    728.5    728.8    728.9    729.1    729.5    737.2
$R     10      0.5    710.0        1    723.5    728.4
K       0  RUNOFF                                                    1
```

RATIOS OF PMF - LAKE INNSBROOK

```
K1       INFLOW TO LAKE B
M        1       2   0.086                       1.0                        1
P        0    25.0     102     120     130
T                                                        -1     -93
W2            0.058
X     -1.0    -.10     2.0
K        1     DAM                                        1
K1       PMF ROUTED THRU LAKE B
Y                                1       1
Y1       1                                               80.05     -1
Y4 805.5  805.74  806.47  806.88  807.35  807.84  808.20  808.78  809.44  810.09
Y4810.74  811.37  812.03  812.66  813.30
Y5       0       6      70     137     234     384     530     835    1288    1839
Y5    2422    3250    4117    5099    6196
$A       0    12.9    17.4    31.0
$E     786   805.5     810     820
$$ 805.5
$D 808.1
$L       0      20     207     353     506     636     690
$V 808.1   808.2   809.7   809.8   810.5   810.9   814.0
K        1REACH W                                         1
K1       STREAM ROUTING-LAKE B TO LAKE LUCERN
Y                                1       1
Y1       1
Y6 0.050   0.035   0.050     687     707    7400  0.0103
Y7       0     732     250     712     540     792     545     687     555     687
Y7     560     692     750     712     800     832
K        0  RUNOFF                                        1
K1       INFLOW TO LAKE LUCERN
M        1       2   1.275                       1.0                        1
P        0    25.0     102     120     130
T                                                        -1     -91
W2            0.551
X     -1.0    -.10     2.0
K        3   COMB.                                        1
K1       COMB. OUTFLOW FROM SCHEFFBORG AND B WITH RUNOFF TO LUCERN
K        1     DAM                                        1
```

RATIOS OF PMF - LAKE INNISBROOK

```
K1      PMF ROUTED THRU LAKE LUCERN
Y                                      1       1
Y1     1                                                       337.60      -1
Y4 692.0   692.5   693.0   693.4  694.02  694.42  694.95  695.47  696.16  696.85
Y4697.39  697.91  698.43  698.95  699.51  700.08  700.64  701.34  702.03
Y5     0      22      53      54      98     191     409     728    1308    2029
Y5  2702    3446    4282    5218    6351    7569    8868   10606   12446
$A     0    42.2    57.9    80.1   103.8
$E   668     692     700     710     720
$$ 692.0
$D 697.2
$L     0     258     309     554     575     625     675     696     701
$V 697.2   697.5   697.7   697.9   698.2   699.5   702.6   702.9   708.9
$B    10     0.5     678       1   692.0   697.2
K      0  RUNOFF                                         1
K1      INFLOW TO LAKE 30520
M      1       2   0.055                   1.0                           1
P      0    25.0     102     120     130
I                                                       -1     -93
W2          0.062
X   -1.0    -.10     2.0
K      1     DAM                                         1
K1      PMF ROUTED THRU LAKE 30520
Y                                      1       1
Y1     1                                                        48.30      -1
Y4 751.0  751.55  751.78  752.25  752.86  753.08  753.31  753.40  753.94  754.46
Y4754.98  755.36  755.68  756.17  756.67  757.05  757.55
Y5     0       6      12      36     101     131     203     238     494     838
Y5  1271    1684    2141    3020    4090    5024    6455
$A     0     6.9    10.1    14.5 [illegible]
$E   730     751     760     770 [illegible]
$$ 751.0
$D 753.1
$L     0      86     303     333     450     406     599     685     760
$V 753.1   753.4   753.7   753.8 [illegible] 754.0   754.5   755.1   760.1
$B    10     0.5   739.5       1   751.0   753.1
K      0  RUNOFF                                         1
```

RATIOS OF PMF - LAKE [illegible]

```
K1       INFLOW TO LAKE C
M     1        2   0.045                    1.0                        1
P     0     25.0    102     120     130
T                                                    -1     .01
W2          0.055
X   -1.0    -.10    2.0
K     1      DAM                                      1
K1       PMF ROUTED THRU LAKE C
Y                                   1       1
Y1    1                                           19.27      -1
Y4 762.4   763.4   763.9   764.9   765.9   766.9   767.9   768.9   769.9   770.9
Y4 771.9
Y5    0      2.5     3.5     4.9     6.1     7.0     7.8     8.6     9.3     9.9
Y5  10.5
$A    0      3.4     7.2    11.2
$E  744      761     770     780
$$ 762.4
$D 762.8
$L    0       98     200     239     454     461     625
$V 762.8   763.9   764.0   764.1   764.3   764.4   771.3
$B   10      0.5     749       1   762.4   762.8
K     0  RUNOFF                                       1
K1       INFLOW TO LAKE 31443
M     1        2    .079                    1.0                        1
P     0     25.0    102     120     130
T                                                    -1     .90
W2          0.055
X   -1.0    -.10    2.0
K     1      DAM                                      1
K1       PMF ROUTED THRU LAKE 31443
Y                                   1       1
Y1    1                                           53.24      -1
Y4 722.0   723.0   723.9  724.59  725.29  726.02  726.74  727.46
Y5    0      8.2    13.2    51.5   294.7   710.4  1247.4  1896.5
$A    0     5.85     9.2    17.7    19.2   24.79
$E 694.7     722     730     740     750     760
$$  722
$D  724
$L    0      117     178     200     232     243     350     387
$V  724    724.3   724.4   724.5   724.6   724.7   724.8   728.6
$B   10      0.5   708.4       1     722     724
K     0  RUNOFF                                       1
```

RATIOS OF PMF - LAKE INNSBROOK

```
K1      INFLOW TO LAKE INNSBROOK
M      1       2   1.432                       1.0                          1
P      0    25.0     102     120     130
T                                                     -1     -90
W2          0.458
X   -1.0    -.10     2.0
K      5    COMB.                                      1
K1      COMB. OUTFLOW FROM LUCERN,30520,C AND 31443 WITH INFLOW FROM INNSBROOK
K      1     DAM                                       1
K1      PMF ROUTED THRU LAKE INNSBROOK
Y                              1       1
Y1     1                                        514.32      -1
Y4 668.6   669.3   669.8   671.2   673.1  673.85  674.29   675.0   675.7  676.39
Y4677.07  677.75  678.40  679.08  679.74  680.66  681.37  682.08  682.78
Y5     0      34      72      79      88     109     144     224     328     456
Y5   604     778     968    1240    1578    2215    2770    3365    4007
$A     0    46.1    66.0    87.5   111.1
$E   635   668.6     680     690     700
$$ 668.6
$D 678.7
$L    25      88     342     375     425     475     525     575
$V 678.7   678.8   678.9   679.3   681.2   683.9   688.6   696.1
K     99
```

LAKE A

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 14. | 29. | 46. |
| CAPACITY= | 0. | 41. | 157. | 380. | 753. |
| ELEVATION= | 743. | 760. | 770. | 780. | 790. |

LAKE 30512

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 11. | 18. | 26. |
| CAPACITY= | 0. | 63. | 151. | 294. | 513. |
| ELEVATION= | 742. | 770. | 780. | 790. | 800. |

LAKE [illegible]

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 11. | 17. | 31. | 54. |
| CAPACITY= | 0. | [illegible] | [illegible] | 409. | 841. |
| ELEVATION= | 702. | 724. | [illegible] | 740. | 750. |

LAKE B

| | | | | |
|---|---|---|---|---|
| SURFACE AREA= | 0. | 13. | 17. | 31. |
| CAPACITY= | 0. | 84. | 152. | 391. |
| ELEVATION= | 796. | 806. | 810. | 820. |

LAKE LUCERN

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 47. | 58. | 80. | 104. |
| CAPACITY= | 0. | 338. | 736. | 1423. | 2340. |
| ELEVATION= | 668. | 692. | 700. | 710. | 720. |

LAKE 30520

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 7. | 10. | 14. | 19. |
| CAPACITY= | 0. | 49. | 174. | 244. | 413. |
| ELEVATION= | 730. | 751. | 760. | 770. | 780. |

LAKE C

| | | | | |
|---|---|---|---|---|
| SURFACE AREA= | 0. | 3. | 7. | 12. |
| CAPACITY= | 0. | 19. | 64. | 160. |
| ELEVATION= | 744. | [illegible] | [illegible] | [illegible] |

LAKE [illegible]

| | | | | | | |
|---|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 4. | [illegible] | 10. | [illegible] | 25. |
| CAPACITY= | 0. | [illegible] | [illegible] | 245. | 430. | [illegible] |
| ELEVATION= | 725. | [illegible] | [illegible] | 740. | 750. | 760. |

LAKE [illegible]

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | [illegible] | [illegible] | [illegible] | 111. |
| CAPACITY= | 0. | [illegible] | [illegible] | [illegible] | [illegible] |
| ELEVATION= | [illegible] | [illegible] | [illegible] | [illegible] | 700. |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE A

| ....... | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 760.00 | 760.00 | 765.50 |
| STORAGE | 41. | 41. | [illegible] |
| OUTFLOW | 0. | 0. | [illegible] |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 764.14 | 0.00 | [illegible] | 18. | 0.00 | [illegible] | 0.00 |
| .15 | 765.54 | .04 | [illegible] | [illegible] | .27 | 18.42 | [illegible] |
| .20 | 765.65 | [illegible] | [illegible] | 1405. | .46 | [illegible] | [illegible] |
| .25 | 766.15 | .65 | 101. | 1500. | .56 | 16.67 | 15.67 |
| .30 | [illegible] | [illegible] | [illegible] | 1778. | .71 | 16.25 | 15.25 |
| .40 | 765.76 | .26 | 97. | 1531. | .48 | 15.33 | 14.33 |
| .50 | 765.77 | .27 | 97. | 1580. | .50 | [illegible] | 13.67 |
| 1.00 | 765.57 | .07 | 94. | 1210. | .33 | 15.92 | 11.50 |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE 30512

| ....... | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 770.00 | 770.00 | 772.40 |
| STORAGE | 63. | 63. | 80. |
| OUTFLOW | 0. | 0. | 263. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 770.72 | 0.00 | 67. | 35. | 0.00 | 15.92 | 0.00 |
| .15 | 770.95 | 0.00 | 69. | 57. | 0.00 | 15.92 | 0.00 |
| .20 | 771.17 | 0.00 | 71. | 79. | 0.00 | 15.83 | 0.00 |
| .25 | 771.39 | 0.00 | 72. | 101. | 0.00 | 15.83 | 0.00 |
| .30 | 771.58 | 0.00 | 74. | [illegible] | 0.00 | 15.83 | 0.00 |
| .40 | 771.94 | 0.00 | 76. | 181. | 0.00 | 15.83 | 0.00 |
| .50 | 772.27 | 0.00 | 79. | [illegible] | 0.00 | 15.83 | 0.00 |
| 1.00 | 773.55 | 1.15 | 89. | 620. | .97 | 15.75 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE SCHEFFBORG

| ........ | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 723.50 | 723.50 | 728.40 |
| STORAGE | 79. | 79. | 144. |
| OUTFLOW | 0. | 0. | 1300. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 725.81 | 0.00 | 107. | 338. | 0.00 | 16.00 | 0.00 |
| .15 | 727.78 | 0.00 | 134. | 1015. | 0.00 | 18.50 | 0.00 |
| .20 | 728.56 | .16 | 144. | 2111. | .29 | 17.92 | 16.92 |
| .25 | 728.49 | .09 | 145. | 2755. | .42 | 17.08 | 16.08 |
| .30 | 729.37 | .97 | 159. | 2857. | .67 | 16.48 | 15.83 |
| .40 | 729.09 | .69 | 155. | 4004. | .87 | 15.98 | 15.17 |
| .50 | 729.09 | .69 | 155. | 3440. | .56 | 15.92 | 14.50 |
| 1.00 | 729.27 | .87 | 158. | 4693. | .50 | 15.92 | 12.50 |

SUMMARY OF DAM SAFETY ANALYSIS

PMF - LAKE B

| ........ | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 805.50 | 805.50 | 808.10 |
| STORAGE | 84. | 84. | 121. |
| OUTFLOW | 0. | 0. | 489. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 806.03 | 0.00 | 91. | 30. | 0.00 | 16.00 | 0.00 |
| .15 | 806.22 | 0.00 | 93. | 47. | 0.00 | 15.92 | 0.00 |
| .20 | 806.40 | 0.00 | 94. | 64. | 0.00 | 15.92 | 0.00 |
| .25 | 806.58 | 0.00 | 98. | 86. | 0.00 | 15.92 | 0.00 |
| .30 | 806.74 | 0.00 | 101. | 110. | 0.00 | 15.92 | 0.00 |
| .40 | 807.04 | 0.00 | 105. | 144. | 0.00 | 15.83 | 0.00 |
| .50 | 807.31 | 0.00 | 109. | 224. | 0.00 | 15.83 | 0.00 |
| 1.00 | 808.32 | .22 | 121. | 597. | .42 | 15.75 | 0.00 |

PMF - CHANNEL TO LAKE LUCERN

PLAN 1 STATION ACH W

| RATIO | MAXIMUM FLOW, CFS | MAXIMUM STAGE, FT | TIME HOURS |
|---|---|---|---|
| .10 | 77. | 687.6 | 16.83 |
| .15 | 42. | 687.9 | 16.75 |
| .20 | [illegible] | [illegible] | 16.50 |
| .25 | [illegible] | 688.4 | 16.33 |
| .30 | 100. | 688.6 | 16.25 |
| .40 | 146. | 689.1 | 16.17 |
| .50 | 201. | 689.5 | 16.17 |
| 1.00 | 514. | 691.2 | 16.00 |

SUMMARY OF DAM SAFETY ANALYSIS
PMF - LAKE LUCERN

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 692.00 | 692.00 | 697.20 |
| STORAGE | 338. | 338. | 582. |
| OUTFLOW | 0. | 0. | 2465. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S. ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 695.38 | 0.00 | 491. | 671. | 0.00 | 16.83 | 0.00 |
| .15 | 696.11 | 0.00 | 527. | 1267. | 0.00 | 16.58 | 0.00 |
| .20 | 697.14 | 0.00 | 579. | [illegible] | 0.00 | 18.00 | 0.00 |
| .25 | 697.55 | .35 | [illegible] | [illegible] | .51 | 17.25 | 16.25 |
| .30 | 698.06 | .86 | 625. | 6206. | .96 | 17.00 | 16.00 |
| .40 | 698.39 | 1.19 | 646. | 7979. | 1.13 | 16.78 | 15.50 |
| .50 | 697.65 | .45 | 606. | [illegible] | 1.77 | 16.17 | 14.75 |
| 1.00 | 699.11 | 1.91 | [illegible] | [illegible] | 2.44 | 16.17 | [illegible] |

SUMMARY OF DAM SAFETY ANALYSIS
PMF - LAKE 30520

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 751.00 | 751.00 | 753.10 |
| | STORAGE | 48. | 48. | 64. |
| | OUTFLOW | 0. | 0. | 149. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 751.75 | 0.00 | 54. | 11. | 0.00 | 17.08 | 0.00 |
| .15 | 752.03 | 0.00 | 56. | 25. | 0.00 | 16.00 | 0.00 |
| .20 | 752.29 | 0.00 | 57. | 40. | 0.00 | 15.92 | 0.00 |
| .25 | 752.49 | 0.00 | 59. | 62. | 0.00 | 15.92 | 0.00 |
| .30 | 752.68 | 0.00 | 60. | 81. | 0.00 | 15.83 | 0.00 |
| .40 | 753.00 | 0.00 | 63. | 126. | 0.00 | 15.83 | 0.00 |
| .50 | 753.22 | .12 | 64. | 974. | .27 | 16.63 | 15.67 |
| 1.00 | 753.70 | .60 | 68. | 1008. | .52 | 16.38 | 15.42 |

SUMMARY OF DAM SAFETY ANALYSIS
PMF - LAKE C

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 762.40 | 762.40 | 762.80 |
| | STORAGE | 24. | 24. | 26. |
| | OUTFLOW | 0. | 0. | 1. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 762.82 | .02 | 26. | 443. | .15 | 14.08 | 13.42 |
| .15 | 762.81 | .01 | 26. | 445. | .15 | 13.08 | 12.42 |
| .20 | 762.80 | .00 | 26. | 437. | .13 | 12.00 | 11.33 |
| .25 | 762.81 | .01 | 26. | 438. | .13 | 10.83 | 10.17 |
| .30 | 762.80 | .00 | 26. | 439. | .10 | 10.00 | 9.33 |
| .40 | 762.80 | .00 | 26. | 442. | .13 | 9.08 | 8.42 |
| .50 | 762.82 | .02 | 26. | 444. | .15 | 8.58 | 7.92 |
| 1.00 | 762.82 | .02 | 26. | 566. | .17 | 15.67 | 6.75 |

## SUMMARY OF DAM SAFETY ANALYSIS
PMF - LAKE 31443

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 722.00 | 722.00 | 724.00 |
| | STORAGE | 53. | 53. | 66. |
| | OUTFLOW | 0. | 0. | 19. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 723.43 | 0.00 | 62. | 11. | 0.00 | 18.33 | 0.00 |
| .15 | 724.00 | .00 | 66. | 826. | .13 | 17.88 | 17.00 |
| .20 | 724.21 | .21 | 67. | 861. | .33 | 16.52 | 15.67 |
| .25 | 724.40 | .40 | 68. | 898. | .42 | 16.35 | 15.50 |
| .30 | 724.03 | .03 | 66. | 1031. | .21 | 15.79 | 14.92 |
| .40 | 724.07 | .07 | 66. | 894. | .27 | 14.96 | 14.08 |
| .50 | 724.06 | .06 | 66. | 905. | .25 | 14.31 | 13.42 |
| 1.00 | 724.01 | .01 | 66. | 919. | .17 | 12.50 | 11.58 |

## SUMMARY OF DAM SAFETY ANALYSIS
PMF - LAKE INNSBROOK

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 668.60 | 668.60 | 678.70 |
| | STORAGE | 516. | 516. | 1068. |
| | OUTFLOW | 0. | 0. | 1088. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .10 | 675.74 | 0.00 | 888. | 335. | 0.00 | 19.92 | 0.00 |
| .15 | 678.93 | .23 | 1082. | 1216. | 1.75 | 19.00 | 0.00 |
| .20 | 679.90 | 1.20 | 1145. | 2973. | 3.58 | 18.08 | 0.00 |
| .25 | 681.01 | 2.31 | 1220. | 6307. | 5.08 | 17.33 | 0.00 |
| .30 | 681.30 | 2.60 | 1240. | 7345. | 5.50 | 17.00 | 0.00 |
| .40 | 682.28 | 3.58 | 1304. | 11171. | 6.67 | 16.33 | 0.00 |
| .50 | 682.53 | 3.83 | 1325. | 12543. | 7.58 | 16.25 | 0.00 |
| 1.00 | 684.69 | 5.99 | 1484. | 24060. | 10.92 | 16.25 | 0.00 |

Group 4.

Lake Innsbrook - 1 Percent Probability
(100-Year Frequency) Flood

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A1 | ANALYSIS OF DAM OVERTOPPING USING 100-YR STORM (1% PROBABILITY STORM) | | | | | | | | | |
| A2 | HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE INNSBROOK DAM | | | | | | | | | |
| A3 | 100-YR STORM ROUTED THROUGH RESERVOIR | | | | | | | | | |
| B | 288 | 0 | 5 | | | | | | 4 | |
| B1 | 5 | | | | | | | | | |
| J | 1 | 1 | 1 | | | | | | | |
| J1 | 1.00 | | | | | | | | | |
| K | 0 | RUNOFF | | | | | 1 | | | |
| K1 | INFLOW TO LAKE A | | | | | | | | | |
| M | 0 | 2 | 0.268 | | | 1.0 | | | 1 | |
| O | 288 | 7.094 | | | | | | | | |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .024 | .024 |
| 01 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 |
| 01 | .024 | .024 | .024 | .024 | .024 | .024 | .029 | .029 | .029 | .029 |
| 01 | .029 | .029 | .060 | .060 | .060 | .060 | .060 | .060 | .129 | .129 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | .130 | .247 | .247 | .544 | .826 | .380 | .247 | .130 | .130 | .129 |
| 01 | .060 | .060 | .060 | .060 | .060 | .040 | .029 | .029 | .029 | .029 |
| 01 | .029 | .029 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 |
| 01 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 | .024 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 | .014 |
| 01 | .014 | .014 | .014 | .014 | .014 | .014 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 |
| 01 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | .006 | | |
| T | | | | | | | -1 | -83 | | |
| W2 | | 0.191 | | | | | | | | |
| X | -1.0 | -.10 | 2.0 | | | | | | | |
| K | 1 | DAM | | | | | 1 | | | |
| K1 | PMF ROUTED THRU LAKE A | | | | | | | | | |
| Y | | | | 1 | 1 | | | | | |
| Y1 | 1 | | | | | | 41.37 | -1 | | |
| Y4 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 |
| Y4 | 770 | | | | | | | | | |
| Y5 | 0 | 2.7 | 10.1 | 14.4 | 17.7 | 20.3 | 22.8 | 24.9 | 27.0 | 28.7 |
| Y5 | 30.4 | | | | | | | | | |
| $A | 0 | 7.3 | 16.4 | 28.9 | 46.2 | | | | | |
| $E | 743 | 760 | 770 | 780 | 790 | | | | | |
| $$ | 760.0 | | | | | | | | | |
| $D | 775.5 | | | | | | | | | |
| $I | 7.4 | 204 | 431 | 513 | 588 | 700 | | | | |
| $V | 765.5 | 765.7 | 766.0 | 766.2 | 768.6 | 773.2 | | | | |
| K | 0 | RUNOFF | | | | | 1 | | | |
| K1 | INFLOW TO LAKE 30512 | | | | | | | | | |
| M | 0 | [illegible] | 0.075 | | | 1.0 | | | 1 | |
| O | 200 | | | | | | | | | |
| T | | | | | | | 1 | -.30 | | |
| W2 | | 0.075 | | | | | | | | |
| X | -1.0 | -.10 | 2.0 | | | | | | | |
| K | 1 | DAM | | | | | 1 | | | |

1% PROBABILITY FLOOD - LAKE INNSBROOK

```
K1      PMF ROUTED THRU LAKE 30512
Y                                 1       1
Y1       1                                               62.53      -1
Y4   770.0   770.3   770.4   770.8   771.4   772.1   772.8   773.3  773.85   774.3
Y4   774.7   775.3   775.9   776.5   777.0   777.4  777.75
Y5       0       4      11      41     102     205     340     467     620     747
Y5     909    1146    1424    1748    2040    2280    2537
$A       0     6.7    11.2    17.7    26.4
$E     742     770     780     790     800
$$   770.0
$D   772.4
$L       0      50      80     154     394     465     500     550     600
$V   772.4   773.4   773.7   773.9   774.3   774.5   776.4   779.7   782.0
K        0  RUNOFF                                       1
K1      INFLOW TO LAKE SCHEFFBORG
M        0       2   0.545                   1.0                             1
O     -288
T                                                       -1     -78
W2           0.197
X     -1.0    -.10     2.0
K        3 COMBINE                                       1
K1       COMB OF OUTFLOW FROM A AND 30512 WITH RUNOFF TO SCHEFFBORG
K        1    DAM                                        1
K1      PMF ROUTED THRU LAKE SCHEFFBORG
Y                                 1       1
Y1       1                                               78.83      -1
Y4   723.5  723.62  724.03  724.75  725.45  726.14  726.82  727.49  728.15  728.68
Y4728.91    729.49  730.09  730.81  731.54  732.27  732.99  733.72  734.44
Y5       0       1      23     113     248     427     635     887    1176    1438
Y5    1563    1912    2319    2874    3473    4111    4787    5499    6247
$A       0    11.0    17.3    31.2    54.3
$E     702   723.5     730     740     750
$$   723.5
$D   728.4
$L       0      25     138     317     350     363     400
$V   728.4   728.5   728.8   728.9   729.1   729.5   737.2
K        0  RUNOFF                                       1
K1      INFLOW TO LAKE B
M        0       2   0.086                   1.0                             1
```

```
O    -288
T                                                                     -1      -84
W2          0.058
X    -1.0    -.10     2.0
K       1     DAM                                                      1
K1          PMF ROUTED THRU LAKE B
Y                                                1       1
Y1      1                                                          83.05      -1
Y4 805.5  805.76  806.47  806.88  807.35  807.84  808.20  808.78  809.44  810.09
Y4810.74  811.39  812.03  812.66  813.30
Y5      0       6      70     132     234     384     530     835    1208    1839
Y5   2492    3250    4117    5099    6196
$A      0    12.9    17.4    31.0
$E    786   805.5     810     820
$$ 805.5
$D 808.1
$L      0      23     207     353     506 [illegible] [illegible]
$V 808.1   808.7   809.2   809.8   810.5   810.9   814.0
K       1REACH W                                                       1
K1          STREAM ROUTING-LAKE B TO LAKE LUCERN
Y                                                1       1
Y1      1
Y6 0.050   0.035   0.050     687     707    7400  0.0103
Y7      0     732     250     712     540     492     545     687     555     687
Y7    540     492     750     712     900     732
K       0  RUNOFF                                                      1
K1          INFLOW TO LAKE LUCERN
M       0       2   1.275                           1.0                        1
O    -288
T                                                                     -1      -79
W2          0.551
X    -1.0    -.10     2.0
K       3   COMB.                                                      1
K1          COMB. OUTFLOW FROM SCHEFFBORG AND B WITH RUNOFF TO LUCERN
K       1     DAM                                                      1
K1          PMF ROUTED THRU LAKE LUCERN
Y                                                1       1
Y1      1                                                          337.60     -1
Y4 692.0   692.5   693.0   693.4  694.02  694.42  694.95  695.47  696.16  696.85
```

```
Y4697.39  697.91  698.43  698.95  699.51  700.08  700.64  701.34  702.03
Y5     0      22      53      54      98     191     409     728    1308    2029
Y5  2702    3446    4282    5218    6351    7569    8868   10606   12446
$A     0    42.2    57.9    80.1   103.8
$E   668     692     700     710     720
$$ 692.0
$D 697.2
$L     0     258     389     554     575     625     675     696     701
$V 697.2   697.5   697.7   697.9   698.2   699.5   702.6   702.9   708.9
K      0  RUNOFF                                   1
K1        INFLOW TO LAKE 30520
M      0       2   0.055                     1.0                         1
O   -288
T                                                 -1     -84
W2         0.062
X   -1.0    -.10     2.0
K      1     DAM                                   1
K1        PMF ROUTED THRU LAKE 30520
Y                                  1       1
Y1     1                                       48.80       1
Y4 751.0  751.55  751.78  752.25  752.84  753.03  753.31  753.40  753.94  754.44
Y4754.98  755.36  755.68  756.17  756.67  757.05  757.55
Y5     0       6      12      34     101     131     203     238     494     838
Y5  1271    1684    2141    3020    4090    5024    6455
$A     0     6.9    10.1    14.3    19.3
$E   730     751     760     770     780
$$ 751.0
$D 753.1
$L     0      86     303     393     450     486     597     685     760
$V 753.1   753.4   753.7   753.8   753.9   754.0   754.5   755.1   760.1
K      0  RUNOFF                                   1
K1        INFLOW TO LAKE I
M      0       2   0.045                     1.0                         1
O   -288
T                                                 -1     -80
W2         0.059
X   -1.0    -.10     2.0
```

1% PROBABILITY FLOOD - LAKE INNSBROOK

```
                                                                    1
K       1      DAM
K1        PMF ROUTED THRU LAKE C
Y                                        1        1
Y1      1                                                 19.27     -1
Y4  762.4    763.4    763.9    764.9    765.9    766.9    767.9    768.9    769.9    770.9
Y4  771.9
Y5      0      2.5      3.5      4.9      6.1      7.0      7.8      8.6      9.3      9.9
Y5   10.5
$A      0      3.4      7.2     11.6
$E    744      761      770      780
$$  762.4
$D  762.8                                         454      461      625
$L      0       98      200      339      454      461      625
$V  762.8    763.9    764.0    764.1    764.3    764.4    771.3
                                                                1
K       0  RUNOFF
K1        INFLOW TO LAKE 31443                      1.0                           1
M       0        2     .079
O    -288                                                        -1       -78
T
W2              0.055
X    -1.0      -.10      2.0                                        1
K       1      DAM
K1        PMF ROUTED THRU LAKE 31443
Y                                       1         1
Y1      1                                                 53.24     -1
Y4  722.0    723.0    723.9   724.59   725.29   726.02   726.74   727.46
Y5      0      8.2     13.2     51.5    594.7    710.4   1247.4   1894.5
$A      0     5.85      9.2     17.7     19.2    24.79
$E  694.7      722      730      740      750      760
$$    722
$D    724                                 232      243      350      387
$L      0      117      170      200      232      243      350      387
$V    724    724.3    724.4    724.5    724.6    724.7    724.8    728.6
                                                                1
K       0  RUNOFF
K1        INFLOW TO LAKE INNSBROOK                  1.0                           1
M       0        2    1.432
O    -288                                                         1       -78
T
```

1% PROBABILITY FLOOD - LAKE INNSBROOK

```
W2          0.458
X    -1.0      .10       2.0
K       5   COMB.                                                  1
K1         COMB. OUTFLOW FROM LUCERN,30520,C AND 31443 WITH INFLOW FROM INNSBROOK
K       1       DAM                                                1
K1         PMF ROUTED THRU LAKE INNSBROOK
Y                                  1         1
Y1      1                                              516.32      -1
Y4 668.6    669.3    669.8    671.2    673.1   673.85  674.29   675.0   675.7  676.39
Y4677.07   677.75   678.40   679.09   679.74   680.66  681.37  682.08  682.78
Y5      0       34       72       79       88     109     144     224     328    456
Y5    606      778      968     1240     1578    2215    2770    3365    4007
$A      0     46.1     66.0     87.5    111.1
$E    665    668.6      680      690      700
$$ 668.6
$D 678.7
$L     25       83      342      375      425     475     525     575
$V 678.7    678.8    678.9    679.3    681.2   683.9   688.6   696.1
K      99
```

SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE A

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 760.00 | 760.00 | 765.50 |
| STORAGE | 41. | 41. | 94. |
| OUTFLOW | 0. | 0. | 22. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 765.64 | .14 | 95. | 38. | 5.58 | 15.[illegible] | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE 30512

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 770.00 | 770.00 | 77[illegible].40 |
| STORAGE | [illegible] | 43. | 80. |
| OUTFLOW | 0. | 0. | [illegible] |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 771.[illegible] | 0.00 | 71. | [illegible]2. | 0.00 | 1[illegible].42 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS
1% PROBABILITY FLOOD - LAKE SCHEFFBORG

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 723.50 | 723.50 | 728.40 |
| | STORAGE | 79. | 79. | 144. |
| | OUTFLOW | 0. | 0. | 1300. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 727.26 | 0.00 | 127. | 801. | 0.00 | 12.58 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS
1% PROBABILITY FLOOD - LAKE B

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 805.50 | 805.50 | 808.10 |
| | STORAGE | 84. | 84. | 121. |
| | OUTFLOW | 0. | 0. | 4[illegible]. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 806.41 | 0.00 | 9[illegible]. | 75. | 0.00 | 12.58 | 0.00 |

PLAN 1 STATION ACH W
1% PROBABILITY FLOOD - CHANNEL TO LAKE LUCERN

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|
| 1.00 | 57. | 488.2 | 13.17 |

SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE LUCERN

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 692.00 | 692.00 | 697.20 |
| | STORAGE | 338. | 338. | 58[illegible]. |
| | OUTFLOW | 0. | 0. | 2465. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 694.26 | 0.00 | 534. | 1408. | 0.00 | 13.33 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE 30520

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 751.00 | 751.00 | 753.10 |
| | STORAGE | 48. | 48. | 64. |
| | OUTFLOW | 0. | 0. | 14[illegible]. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 752.18 | 0.00 | 57. | 3[illegible]. | 0.00 | 12.58 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE C

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 741.00 | 762.40 | 762.80 |
| | STORAGE | 19. | 24. | 26. |
| | OUTFLOW | 0. | 0. | 1. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 763.15 | .35 | 27. | 9. | 11.67 | 13.83 | 0.00 |

SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE 31443

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 722.00 | 722.00 | 724.00 |
| | STORAGE | 53. | 53. | 66. |
| | OUTFLOW | 0. | 0. | 19. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 723.97 | 0.00 | 66. | 17. | 0.00 | 13.75 | 0.00 |

## SUMMARY OF DAM SAFETY ANALYSIS

1% PROBABILITY FLOOD - LAKE INNSBROOK

| ....... | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 668.60 | 668.60 | 678.70 |
| | STORAGE | 516. | 516. | 1068. |
| | OUTFLOW | 0. | 0. | 1088. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 677.04 | 0.00 | 965. | 600. | 0.00 | 16.25 | 0.00 |